Reflections On

RESEARCH and DEVELOPMENT *in the United States Air Force*

An interview with General Bernard A. Schriever and Generals Samuel C. Phillips, Robert T. Marsh, and James H. Doolittle, and Dr. Ivan A. Getting

Conducted by Dr. Richard H. Kohn

Edited and with an introduction by Jacob Neufeld

Center for Air Force History

Washington, D.C.

1993

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
1993		**00-00-1993 to 00-00-1993**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Reflections on Research and Development in the United States Air Force	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Air Force Historical Studies Office,AF/HO,1190 Air Force Pentagon,Washington,DC,20330-1190**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
see report

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**		**107**	

Library of Congress Cataloging-in-Publication Data

Reflections on research and development in the United States Air Force: an interview with General Bernard A. Schriever, and Generals Samuel C. Phillips, Robert T. Marsh, and James H. Doolittle, and Dr. Ivan A. Getting/conducted by Richard H. Kohn; edited and with an introdution by Jacob Neufeld.

p. cm.

Includes bibliographical references.

1. Aeronautics, Military—Research—United States—History.
2. Astronautics, Military—Research—United States—History.
3. United States. Air Force—History. I. Schriever, Bernard A.
II. Kohn, Richard H. III. Neufeld, Jacob.

UG643.R44 1992 92-573

358.4'0072'073—dc20 CIP

The views expressed in this publication are those of the interview participants and do not necessarily reflect the policies of the United States Air Force or the Department of Defense.

Foreword

Reflections on Research and Development in the United States Air Force was intended to be part of the now-defunct Warrior Series. While the necessity for that particular series has lapsed, its long-term goal remains valid—to produce books which will appeal to all levels of Air Force people, who may learn from the past and perhaps apply the experiences of past generations to the present.

This publication should interest readers who have scant familiarity with research and development, as well as those intimately familiar with the subject. The former will gain an understanding of the outline history of Air Force research and development, while the latter will obtain fresh, personal perspectives.

In 1982 General Lew Allen, Jr. called for "the continuing study of military history, combat leadership, the principles of war, and particularly, the applications of air power." All of us in the Air Force community can benefit from such study and reflection. The challenges of today and the future demand no less.

RICHARD P. HALLION
Air Force Historian

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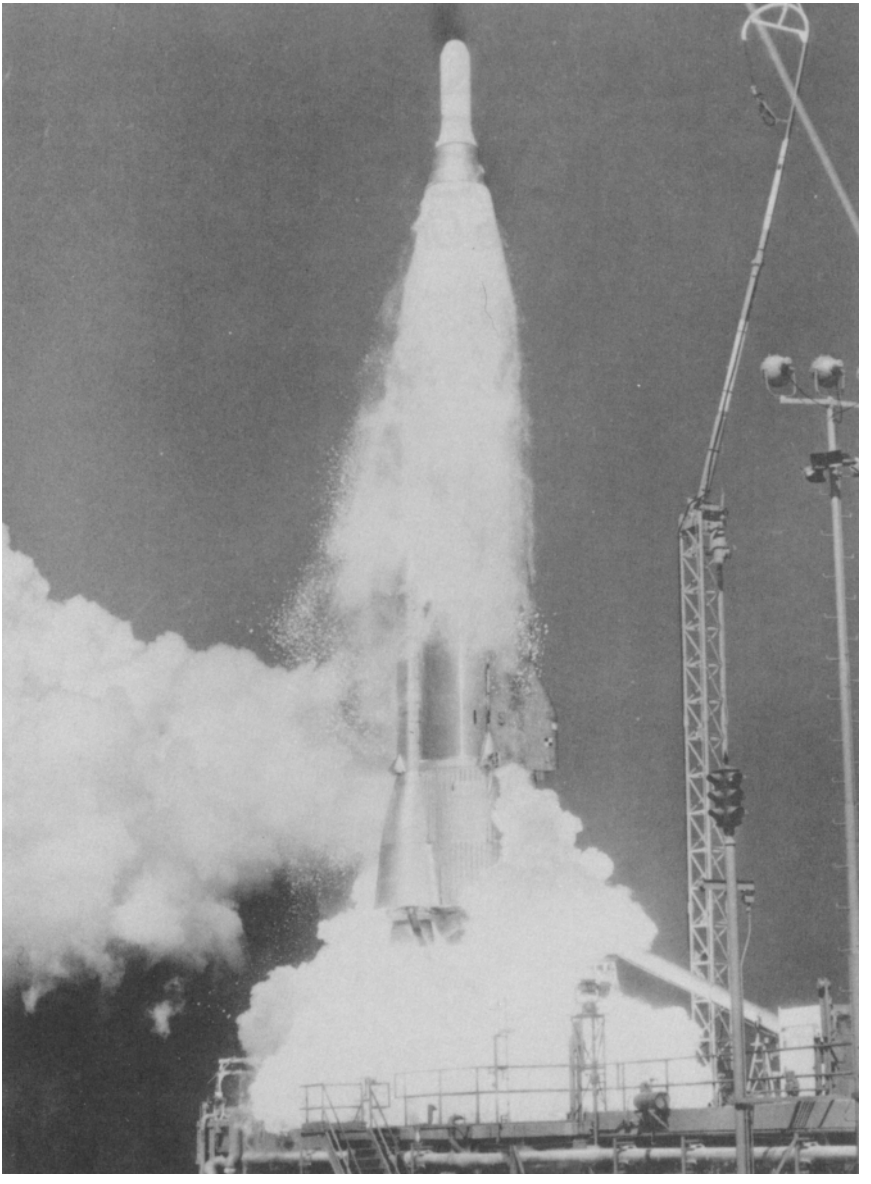

A series E Atlas intercontinental ballistic missile is launched from Cape Canaveral, Florida, beginning its 5,000–mile test flight down the Atlantic Missile Range.

Introduction

This Senior Statesmen seminar, held at Bolling Air Force Base, Washington, D.C., in 1985, explored the research, development and acquisition (RDA) process in the United States Air Force. In particular, the discussion among the participants sought to elicit how that process evolved, whether or not it had been successful, why it changed, and what have been the major influences upon it. Readers will note that the discussion proceeds chronologically and topically from the "Early Days" through the post-World War II era to the 1970s and 1980s.

In the early days, pilots did not fully appreciate the value of research and development. Few had received any technical training and for the most part they cared only about the final product. Competitive air races first brought aviation to public attention and simultaneously fostered new aeronautical research and development. While this science advanced rapidly, the Army's air arm lagged behind American commercial aviation, as well as European commercial and military aviation. Through the early 1930s the Army Air Corps focused on the observation mission while its pilots still flew open cockpit biplanes.

The crux of the problem was that while the three major elements of military aviation, the Army Air Corps, the National Advisory Committee for Aeronautics (NACA), and the aviation industry cooperated with one another, no overall coordinating agency existed. Moreover, with funding for aviation extremely limited, each of the three elements concentrated on its own interests.

The major turning point in the evolution of the RDA process was the Army's air mail experience. In the winter of 1934 President Franklin D. Roosevelt was embroiled in a dispute with the air lines involving fraud and collusion in government contracts. Consequently, he directed the Army Air Corps to substitute for commercial air mail carriers. This episode proved a sobering experience as Air Corps pilots and planes were unprepared for the mission on account of their inability to fly in bad weather and over unfamiliar terrain. As Air Corps losses mounted steadily, public criticism obliged the government to commission a formal investigation. Subsequently, Newton D. Baker, the former Secretary of War, headed a board which recommended modernizing the air arm. Fortuitously, the Baker Board also addressed numerous deficiencies, and resolution of these was vital for conducting aerial warfare. By 1939 the Air Corps had embarked on an ambitious

research and development (R&D) program and was flying practically every airplane which would be used during World War II.

President Roosevelt recognized the need for coordinating research and named Dr. Vannevar Bush of the Massachusetts Institute of Technology (MIT) to head an agency called the National Defense Research Committee (NDRC). As war approached NDRC helped liberate funding for aeronautical research and mobilized thousands of engineers and scientists. (For example, MIT's Radiation Laboratory, established in October 1940, grew into an organization of several thousand within a year.) The NDRC, which was later renamed the Office of Scientific Research and Development, concentrated on navigation, radar, and communications and established an advisory relationship with the military, much as NACA had done.

In May 1940 President Roosevelt called on the nation to produce 50,000 aircraft per year, an "impossible" goal at that time. Industry moved quickly during the next few years to comply. In the process Douglas Aircraft virtually built Santa Monica, California. Ironically, however, the rush to produce airplanes hampered innovation. Also, the expedient "marriage" between the aviation and automobile industries proved unhappy as aviation jealously guarded its secrets, while the auto makers sought to emphasize their forte—mass production.

Nonetheless, development progressed on such new weapons as the atomic bomb, jet aircraft, and rockets. As mentioned earlier, the war had triggered a revolution in electronics, a joint effort undertaken by researchers at the Radiation Laboratory, Wright Field, and Proving Ground Command at Eglin Field. Because the Army Air Forces (AAF) belonged to the U.S. Army, it was poorly organized to conduct research and did not control its own budget, or the development of its own weapons or equipment. For example, the Signal Corps provided radar and communications, while Ordnance produced machine guns. Moreover, the AAF did not employ any formal management system, and everyone was expected to "pitch in." Despite these limitations, the AAF's R&D effort proved successful, largely because it employed expert consultants. For example, Dr. Edward Bowles, a special assistant to Secretary of War Henry L. Stimson, also worked with the AAF on new technologies and equipment.

Once the war ended scientists were anxious to return to their universities. But General Henry H. "Hap" Arnold recognized the importance of the technological revolution, particularly its potential impact on air power, and he determined to preserve the invaluable wartime military-scientific cooperation by identifying and recruiting the "best brains available."[1] The AAF Scientific Advisory Group (later Board) became part of the U.S. Air Force "family."

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[1] Thomas A. Sturm, *The USAF Scientific Advisory Board: Its First Twenty Years, 1944–1964,* Wash, DC: USAF Historical Division Liaison Office, February 1, 1967, p 2.

Late in 1944 Arnold commissioned Theodore von Kármán to survey the war's technological achievements and chart a future course for the proposed independent Air Force. Von Kármán's monumental report, *Towards New Horizons*, set the postwar military-scientific relationship on a solid footing. The von Kármán document and the earlier report, *Science, the Key to Air Supremacy*, "made plain the preeminence of the AAF in protecting the nation, but also asserted that its success rested in large part on technological progress."[2] With this aim in view, the eminent scientist managed to "liberate" several German wind tunnels for what was to become the Arnold Engineering Development Center (AEDC) at Tullahoma, Tennessee.

Undoubtedly, the central event of the postwar period for the American military was the passage of the National Security Act, which created the Department of Defense and the United States Air Force in September 1947. Gaining independence from the Army had preoccupied air leaders for years and at first the event overshadowed all else. After General Arnold retired in 1946, his successors concentrated on maintaining "forces in being," (i.e., readiness and force structure); this came at the expense of R&D. A key element of the problem involved the Air Force's organization. Air Materiel Command, headquartered at Wright Field, near Dayton, Ohio, absorbed a multitude of activities including logistics and maintenance, with "engineering" thrust into the background. Indeed, most of this so-called engineering was directed more at improving existing weapons than in developing new ones.

Several individuals, especially retired Lt. Gen. James H. Doolittle, appreciated the organizational problems and worked to resolve them. Doolittle understood that restoring R&D to the forefront of decision-making required a strong institutional advocate. In 1949 the aviation pioneer happened to be working as a special assistant to Air Force Chief of Staff General Hoyt S. Vandenberg.[3] Doolittle used his influence to commission the Ridenour and Anderson Reports, which recommended establishing two new R&D advocacy entities: a new major command and a new deputy chief of staff, both of which were created in 1950. In 1951, in an attempt to emphasize the technical aspects of decisionmaking, Headquarters USAF reorganized the Assistant for Evaluation into the Development Planning Office. Earlier, the War Department's R&D functions were reorganized in concert with the 1947 National Security Act. Thus, one of the Army's premier R&D labs, the Watson Laboratory, was split, with a portion ending up at Rome, New York. Similarly, parts of the Army Radiation Laboratory were broken off and assigned to the Cambridge

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[2] Michael H. Gorn, *Harnessing the Genie: Science and Technology Forecasting for the Air Force, 1944–1986*, Wash, DC: Office of Air Force History, 1988, p 41.

[3] General Vandenberg (1899–1954) was the first Vice Chief of Staff, from October 1947 until April 1948, when he succeeded General Spaatz as Air Force Chief of Staff. Vandenberg served as Chief of Staff until June 1953.

Research Laboratory. These facilities undertook to assess and correct several serious deficiencies besetting the Air Force, including the lack of a night fighter capability, airborne intercept equipment, and an air to ground communications link. In response to these priorities, Headquarters USAF established the Air Defense Systems Engineering Committee, a precursor of MIT's Project Lincoln.

As the postwar air leaders struggled to improve the service's R&D organization, they faced severe funding limitations until the onset of the Korean War in June 1950 stimulated government spending. During the defense buildup, the Congress did not control military spending effectively. Instead, it provided "bulk appropriations" for R&D which each service was allowed to spend as it saw fit. Moreover, the services themselves administered foreign military sales and spent the resulting credits as they saw fit. These arrangements enabled the Air Force to fund key developments, such as jet engines.

Some organizational difficulties remained despite the creation of the separate Air Research and Development Command (ARDC) in 1950. The Air Materiel Command (AMC) had resisted consummating the reorganization, denying ARDC the authority to issue procurement warrants. Thus evolved a complicated procedural arrangement in converting a project from R&D to procurement.

The fledgling Air Force immediately recognized the importance of technical education to its officer corps. Gen. Samuel C. Phillips attended the University of Michigan in 1947 to study electronics and Gen. Robert T. Marsh enrolled in a guided missiles course there in 1952. These men formed the vanguard of hundreds of Air Force officers who volunteered to study science at major universities. Simultaneously, the Air Force upgraded its Air Force Institute of Technology, the successor to the Engineering School at Wright Field. Top Air Force graduates went on to MIT to study inertial guidance, missiles, and space systems at Dr. Stark Draper's Instrumentation Laboratory. Beginning in 1947 the Air Force elevated educational requirements for technical officers and established a promotion system enabling these officers to rise in rank. Indeed, General Lew Allen, Jr., with a PhD in physics, went on to become Air Force Chief of Staff in 1978.

R&D's usefulness was put to the test with the intercontinental ballistic missile (ICBM) program. The program, which was successful for numerous reasons, received the Defense Department's highest priority, enabling the Air Force to create a unique and revolutionary streamlined management approach. This management procedure, which included concurrent development, established the pattern for all of ARDC. By 1961 the command had adopted the associate contractor method, especially in missile and space programs, thereby reserving more control to the Air Force. Trevor Gardner, the Assistant Secretary of the Air Force for Research and Development, an exceptionally energetic and competent individual, successfully promoted the program. General

Thomas S. Power, the ARDC commander, invested General Bernard A. Schriever with full management authority. Despite AMC institutional resistance, AMC commanders Generals Edward W. Rawlings and William F. "Bozo" McKee cooperated with Schriever with respect to funding the ICBM program. Dr. John von Neumann's Scientific Advisory Committee also afforded the program credibility in its dealings outside the government. Congress shared the Air Force's "sense of crisis" and cooperated fully.

Meanwhile, in 1956, as the management revolution in missiles progressed, the rest of ARDC's program managers watched with interest. General Phillips, the B–52 manager at Wright Patterson AFB, set up an integrated operation which oversaw engineering, procurement, and acquisition and prepared new systems for operational deployment. By the time he became director for the Minuteman ICBM development in 1959, Phillips's integrated program comprised seventeen separate sections. Benefitting from previously tested administrative procedures,[4] the Minuteman program avoided much of the usual red tape and was able to concentrate instead on planning and execution. In October 1962, only four years after the program had begun, the first flight of Minuteman missiles came on alert status.

The ICBM program marked the transition from the prime to the associate contracting method, eliminating many of the abuses under the former system. In the following interview, Dr. Ivan Getting relates his experience while he was a vice president for Raytheon. At the time, Convair, the prime contractor for the B–58 bomber, had employed Sperry to develop the new bombing and navigation system, with Raytheon serving as a subcontractor to Sperry. Under the arrangement, however, Raytheon was permitted to communicate only with Sperry. Presumably, the arrangement was meant to enable Convair to take advantage of all of the technical tradeoffs. The associate contractor system, on the other hand, granted the Air Force access to all of its contractors, thereby surfacing all of their programs.

The Ballistic Missile Division's management success drew considerable attention and led to the system's institutionalization under Air Force series –375 regulations. Unhappily, the regulations were constantly expanded up to the DOD level where bureaucratization took hold. The Air Force applied for waivers from the onerous regulations, but was thwarted time after time. Perhaps the lesson drawn here was that no single management approach could long survive in any bureaucracy.

Meanwhile, in April 1959 General Schriever assumed command of ARDC. Anxious to remedy the ARDC and AMC interface, Air Force Secretary Douglas ordered Generals Schriever and Samuel Anderson, AMC commander, to study the arrangements governing acquisition between their respective com-

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[4] Jacob Neufeld, *The Development of Ballistic Missiles in the United States Air Force, 1945–1960,* Wash, DC: Office of Air Force History, 1990, Appendix 2.

mands. The generals commissioned a group of senior colonels to conduct the study. As a result the colonels recommended a restructuring which separated (along command lines) R&D from logistics, supply, and maintenance. While Schriever favored the colonels' recommendations, Anderson was opposed. Subsequently, Headquarters USAF adjusted the existing weapons systems project office organization somewhat, but made no significant changes. Although the system worked after a fashion, its awkwardness made industrial firms unsure as to where authority lay and they tended to gravitate toward those organizations which controlled funding.

As Secretary of Defense, Robert S. McNamara had instituted some major reform measures, including centralized administration and the controversial policy of forcing commonality of weapon systems on the services. Another requirement he introduced in this period of cost effectiveness was detailed program oversight, also called micromanagement by its critics. Those critics charged that the extension of micromanagement unnecessarily lengthened the R&D life cycle, adding time and cost to most military weapon systems.

With the advent of the Kennedy administration in 1961, Roswell Gilpatric, McNamara's Deputy Secretary of Defense, promised to assign to the Air Force the space mission, provided the service resolved the organizational problems involving ARDC and AMC. The Air Force Chief of Staff, General Thomas D. White, agreed and the Air Force quickly abolished the older commands and replaced them with Air Force Systems Command (AFSC) and Air Force Logistics Command (AFLC). AFSC inherited the entire R&D function, including acquisition, while AFLC assumed responsibility for logistics, maintenance, and supply functions. Consequently, the Air Force was soon named executive agent for space R&D.

However, much of the reorganization's promise did not materialize due to the demands of the Vietnam War. Like other military agencies, AFSC did not make policy decisions, but responded to requirements. As wartime demands for equipment modifications interrupted new systems development, AFSC adapted quickly and effectively to these requirements. At Wright-Patterson AFB a "basket" systems program office (SPO) was established to handle a diversity of equipment, including electronic warfare, reconnaissance, and gunships. Primarily, the SPO succeeded because it avoided complying with the –375 series regulations. For example, when the Air Force ran out of chaff for its aircraft, the AFSC commander, General George S. Brown, placed the order and then personally guaranteed he would secure the necessary funding later.

Secretary McNamara's tenure in the 1960s was marked by bitter controversy with the military. McNamara tried to impose the concept of "commonality" in weapons procurement by the various services and he cancelled a number of systems under development, including the Air Force's rail-mobile Minuteman. What rankled Air Force leaders, especially General Schriever, was the manner in which these programs were cancelled, "without the benefit

of debate." In an effort to hold back technology, the Department of Defense disapproved the transition from exploratory to advanced development for several important systems. While his critics alleged that he sought to avert heating up the arms race, McNamara himself had cited "insurmountable technical difficulties" as the primary rationale for cancelled weapon systems in development. General Schriever believed that had the nation adopted this stance during the 1950s, it could not have produced the Minuteman ICBM. Ironically, the politically-inspired "missile gap" crisis sustained the effort to build the Air Force's Minuteman and Navy's Polaris systems.

Nevertheless, staking its future on technological advancement, the Air Force undertook in 1963 a wide-ranging survey of promising technologies. Called Project Forecast, the study "argued the necessity of preserving the superiority of the strategic force. . . . [and also] stated the case for a genuine flexible response policy, capable of repelling all acts of aggression short of total nuclear war."[5] Despite McNamara's lack of enthusiasm for Project Forecast, Air Force leaders and scientists pressed on.

Several management and contracting approaches were implemented during the 1970s and 1980s, including fixed-price, cost-plus, multiyear, fly before buy, prototyping, and total package procurement. While almost any organization would likely accommodate to its environment, the key to success lay in careful planning, competent engineering, and rigorous management. Similarly, Air Force leaders believed that it was better to adapt to a bureaucracy than to change it. The key to success was to define a particular mission and then persuade the diverse groups involved to support that mission.

In their retrospective, the seminar participants agreed that the government and industry relationship had to be improved. General Phillips believed this could best be achieved by adopting definite rules and assigning responsibility clearly. They noted the absence of a sense of crisis. Consequently, over the past twenty-five years the Air Force had experienced a continuous erosion of its technical base programs. While the Air Force had traditionally devoted 2 percent of its budget to R&D, that percentile had fallen to 1.3 percent during the 1970s, with the end of the Vietnam War and the Carter administration's drawdown.

Many observers agreed that space remained the area most vital to the Air Force's future. For political reasons, however, the Air Force never had more than a tenuous hold on space activities. Air Force involvement in space dated to the 1946 Rand report on the Earth-circling spaceship and then to the satellite detection systems of the 1950s. But, in an effort to channel space toward peaceful purposes, the Eisenhower administration forbade the military from publicly advocating aerospace programs, restricted military spending to component development, and separated space into military and civilian spheres.

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[5] Gorn, *Harnessing the Genie,* p 107.

Not until after the October 4, 1957 launch of *Sputnik* electrified the world did a sense of crisis prevail. Presidents Kennedy and Johnson continued the separation of civilian and military space and then further fragmented the military's effort by creating more administrative layers, such as the Advanced Research Projects Agency, and assigning strategic space reconnaissance to intelligence. By the early 1980s, however, there were signs indicating a greater appreciation of the importance of space for military purposes, including the issuance of presidential guidelines on space and the creation of a U.S. Space Command.

Several individuals had a hand in this project, most notable Richard H. Kohn, the former Chief, Office of Air Force History, and his successor, Richard P. Hallion, the Air Force Historian. I also wish to express my appreciation to Col. David A. Tretler, Herman S. Wolk, Michael H. Gorn, members of the Office of Air Force History, and Thomas Crouch, of the National Air and Space Museum, who made excellent suggestions for improvement in their capacities as a final review panel. And last, but by no means least, a special debt of gratitude to Miss Karen A. Fleming, my assistant, who performed masterfully in carrying out some detailed research and who edited the work.

Participants

General Bernard A. Schriever (1910–) came to America in 1917 when his family emigrated from Germany. He became a naturalized citizen in 1923 and graduated from Texas A & M University in 1931 with a Bachelor of Science degree in architectural engineering.

He received a commission in Army field artillery, but in July 1932 began flight training at Randolph Field and earned his wings and an Air Corps commission in June 1933 at Kelly Field, Texas. He was assigned as a bomber pilot at March and Hamilton Fields, California, and then went to Albrook Field, Panama. In September 1937 Schriever left the Air Corps to fly as a pilot with Northwest Airlines. He returned to military duty in October 1938 with the Seventh Bomb Group at Hamilton Field and a year later became a test pilot at Wright Field, Ohio, where he also attended the Air Corps Engineering School, graduating in July 1941. He received a master's degree in mechanical engineering from Stanford University in June 1942 as a newly appointed major.

In July 1942 Schriever transferred to the Pacific for combat duty with the 19th Bomb Group, taking part in the Bismarck Archipelago, Leyte, Luzon, Papua, Northern Solomons, Southern Philippines, and Ryukyu campaigns. He moved to the Fifth Air Force Service Command in January 1943, and served in maintenance and engineering assignments and as Chief of Staff, eventually becoming Commanding Officer of Advance Headquarters for the Far East Air

General Bernard A. Schriever

Service Command, which supported theater operations from bases in Hollandia, New Guinea, Leyte, Manila, and Okinawa. He was promoted to lieutenant colonel in August 1943 and to colonel that December.

After the war Schriever spent three and a half years at Headquarters AAF as Chief of Scientific Liaison. After graduation from the National War College in June 1950, he returned to Headquarters AAF as Assistant for Evaluation. The following year he continued the same type of work, with the title of Assistant for Development Planning, and was promoted to brigadier general in June 1953. Schriever began his long association with Air Research and Development Command (ARDC) in June 1954 as Assistant to the Commander. He then headed a small group of officers assigned to Los Angeles to organize the predecessor of the Air Force's ballistic and space systems divisions–responsible for the development of key aerospace projects such as Thor, Atlas, Titan, and Minuteman missiles, and various launch systems, including the man-in-space program. Schriever became a major general in December 1955.

He left Los Angeles for Andrews AFB, Maryland, in April 1959 and was promoted to lieutenant general. At Andrews he served as commander of ARDC, which became Air Force Systems Command in April 1961, under a reorganization initiated by him. Schriever was promoted to general in July 1961.

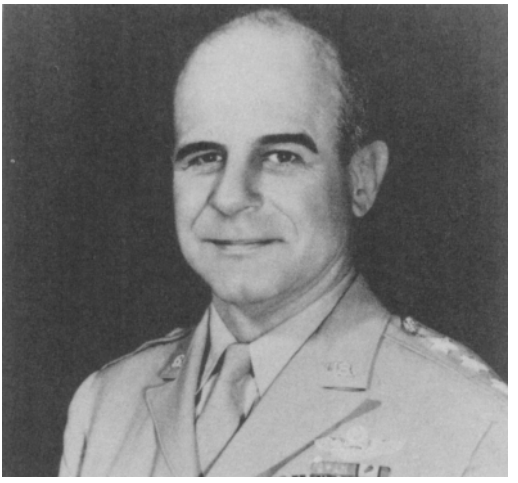
In 1963–64 General Schriever established and directed a study effort called Project Forecast, essentially a survey of future technology for air warfare. Forecast's purpose was to develop a long-range plan to project Air Force technology needs from five to fifteen years.

Since his retirement on August 31, 1966, General Schriever has been in great demand as a consultant to civilian organizations, but frequently he has served without fee as an advisor to the Air Force and the Department of Defense.

Lt. Gen. James H. Doolittle (1896–) was born in Alameda, California. After a year at the California School of Mines, he joined the Signal Corps Reserve in 1917. He won his commission and wings in 1918. The next four years saw a variety of assignments in the Air Service.

In September 1922, Doolittle flew a DH–4 from Pablo Beach, Florida, to San Diego, California, in 21 hours and 19 minutes with only one refueling stop. This feat earned him the Distinguished Flying Cross and became the first of his many aviation accomplishments.

Over the next five years, Doolittle established himself as one of America's leading aviation pioneers. He earned a master of science degree in engineering in and a doctor of science in aeronautics from the Massachusetts Institute of Technology—one of the first people in the country to earn this degree; in 1925 he set a speed record flying a seaplane faster than anyone had ever done before—232 mph; working with Stark Draper at the MIT, he helped develop fog-flying equipment in 1928, which led to wide-spread use of artificial horizon and directional gyroscopes; he made the first "blind" flight completely depen-



Lt. Gen. James H. Doolittle

dent on instruments, for which he won the Harmon Trophy in 1930: and he served as Army advisor on construction of Floyd Bennett Airport in New York City.

Doolittle resigned his regular commission in February 1930 to manage Shell Oil's aviation department. Throughout the thirties, continuing to serve in the reserves, he flew racing planes and frequently advised the government on aviation matters.

Doolittle returned to active duty in July 1940 and served in World War II. He is best remembered for leading the April 18, 1942, B–25 raid on Japan launched from the deck of the aircraft carrier *Hornet*, for which he received the Medal of Honor and promotion to brigadier general. He attained the rank of major general in November 1942 and served as Commanding General of the Twelfth Air Force in North Africa. From January 1944 until the end of the war, Doolittle commanded the Eighth Air Force in Europe. He was promoted to lieutenant general in March 1944. At the end of the war he returned to civilian life and the vice presidency of Shell Oil. He served as a special assistant to the Air Force Chief of Staff for scientific and industrial matters in 1951, and was the final chairman of the NACA.

General Samuel C. Phillips (1921–1990) was born in Springerville, Arizona, on February 19, 1921. He earned a Bachelor of Science degree in electrical engineering from the University of Wyoming in 1942 and a Master's degree in electrical engineering from the University of Michigan in 1950.

After completing Reserve Officers Training Corps and graduating from the University of Wyoming, he was commissioned a second lieutenant, Infantry. He entered active service, transferred to the Army Air Corps, and attended flying school where he earned his wings in 1943.

General Samuel C. Phillips

During World War II, Phillips served with the 364th Fighter Group, Eighth Air Force, in England and completed two combat tours of duty in the European Theater of Operations. After the war, he was assigned to the European Theater Headquarters in Frankfurt, Germany, transferring to Langley Field, Virginia, in July 1947. His research and development assignments, starting in 1950, included six years with the Engineering Division at Wright-Patterson Air Force Base, Ohio; duty as electronics officer with the atomic energy experiments at Eniwetok during Operation GREENHOUSE; and project officer assignments with B–52 bomber aircraft and the Falcon and Bomarc missile programs.

Colonel Phillips returned to England in June 1956, where he served with the 7th Air Division of the Strategic Air Command. For participating in successful negotiations with Great Britain for the deployment and use of the Thor intermediate-range ballistic missile, he earned the Legion of Merit.

He returned to the United States in August 1959 and was assigned to the Air Force Ballistic Missile Division of the Air Research and Development Command, Los Angeles, as Director of the Minuteman Intercontinental Ballistic Missile Program.

As a brigadier general, Phillips was detailed to the National Aeronautics and Space Administration (NASA) in October 1964 to serve as Director of the *Apollo* Manned Lunar Landing Program. In September 1969 he assumed command of the Space and Missile Systems Organization (SAMSO), Air Force Systems Command, in Los Angeles. Phillips became Director, National Security Agency/Chief, Central Security Service in August 1972, and the following year Commander, Air Force Systems Command, Andrews Air Force Base, Maryland. He retired from the Air Force in September 1975, after serving 33 years. Upon retirement he joined Thompson-Ramo-Wooldridge (TRW) as

general manager of the Energy Systems Management Division. This led to an appointment as vice president of TRW's Defense Systems Group in 1984. Having retired from TRW in 1986, General Phillips returned to NASA in the wake of the *Challenger* disaster to conduct a management review of the agency.

General Phillips died on January 31, 1990 at his home in Palos Verdes Estates, California.

General Robert T. Marsh (1925–) was born in Logansport, Indiana, on January 3, 1925. He began his military career in 1943 as an enlisted man in the United States Army Air Forces and acquired aerial gunnery and aircraft mechanic training on B–17s and B–24s. In July 1945 Marsh received a Regular Army appointment[6] to West Point, where he earned a B.S. in military arts and sciences. After graduation, he attended the Air Tactical School at Tyndall AFB, Florida, and then trained at the Atomic Weapons and Radiological Safety School at Keesler AFB, Mississippi. He joined the Armed Forces Special Weapons Project in July 1950 as an atomic weapons assembly officer at Sandia Base, New Mexico, and next went to the Fifth Aviation Field Depot Squadron, again as an atomic weapon assembly officer. Marsh transferred to Headquarters 7th Air Division, Strategic Air Command, South Ruislip, England, in December 1952, where he served as an armament and electronics staff officer.

Returning to school in September 1954, he earned a master of science degree in instrumentation and aeronautical engineering from the University of Michigan. In July 1956 he was assigned to Headquarters, Air Research and

General Robert T. Marsh

[6] That is, General Marsh received an appointment based on his enlisted service.

Development Command at Wright-Patterson AFB, Ohio, as a project officer in the Navaho and Matador/Mace weapon systems project offices.

After graduation from the Air Command and Staff College at Maxwell AFB, Alabama, in July 1960, Marsh joined the Ballistic Missile Division, Air Force Systems Command, at Los Angeles AFS, California. In August 1964, he returned to Maxwell AFB to attend the Air War College.

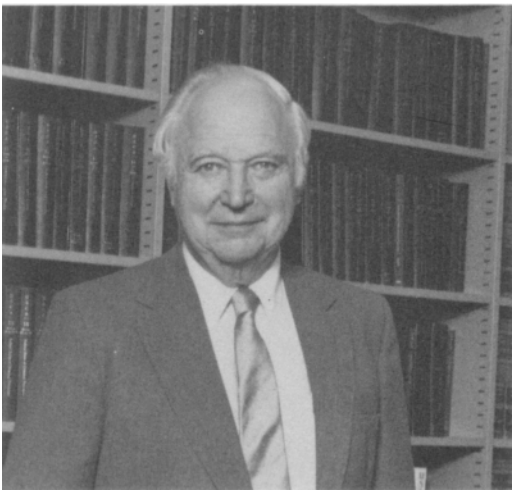
Having attended the Air War College, in June 1965, Marsh was assigned to Headquarters USAF, Washington, D.C., Office of the Deputy Chief of Staff, Research and Development (DCS/R&D), as a staff officer in the Directorate of Reconnaissance and Electronic Warfare. Eventually he became Chief of the Projects Division in the Directorate of Space. He ended his Pentagon tour in August 1969 as executive officer for the DCS/R&D.

Then a brigadier general, Marsh returned to Wright-Patterson AFB as Deputy for Reconnaissance and Strike and Electronic Warfare. He was promoted to major general and became Deputy Chief of Staff for Development Plans, Air Force Systems Command, in June 1973. In October he was named Deputy Chief of Staff for Systems and in August 1975 was appointed Vice Commander.

As a lieutenant general, he transferred to Hanscom AFB, Massachusetts, where he commanded the Electronic Systems Division from May 1977 to January 1981. After this assignment he was promoted to general and became Commander of Air Force Systems Command at Andrews AFB, Maryland. General Marsh retired in August 1984.

Dr. Ivan A. Getting (1912–) was born in 1912 to Czechoslovakian parents living in New York. He received a degree in engineering from the Massachusetts Institute of Technology in 1933. Unable to find work during the Depression, he won a Rhodes Scholarship to Oxford, where he earned a doctorate of philosophy in astrophysics in 1935. He was then appointed a Junior Prize Fellow with Harvard University's Society of Fellows. Getting remained at Harvard, studying nuclear physics and cosmic rays, until November 1940, when he returned to MIT as the director of the Division of Fire Control and Army Radar in MIT's Radiation Laboratory. The renowned physicist also served as head of the Naval Fire Control section of the OSRD, as a member of the Combined Chiefs of Staff Committee on Searchlight and Fire Control, and as a special consultant to Secretary of War Stimson.

In July 1945, Dr. Getting became a professor in MIT's electrical engineering department. He took a year's leave of absence from his teaching (August 1950 to August 1951) during the Korean War to serve as Assistant for Development Planning at Headquarters USAF. From 1951 to 1960, Dr. Getting was associated with Raytheon first as vice president, then as president and trustee. He also served on the boards of many organizations such as Northrop, Verac, and associated universities. In August 1960, Dr. Getting became the



Dr. Ivan A. Getting

first president of the Aerospace Corporation, where he remained until his retirement in 1977.

Throughout his career, Dr. Getting has served on numerous government committees, including the U.S. Air Force Scientific Advisory Board, the Signal Corps Advisory Council, the Undersea Warfare Committee of the National Research Council, the Defense Department's Research and Engineering Advisory Panel on Electronics, the Limited Warfare Panel of the President's Science Advisory Committee (PSAC), the Naval Warfare Panel of PSAC, and the National Security Council.

Dr. Getting has received countless honorary degrees and awards and is currently active as a consultant. He continues his memberships on the Scientific Advisory Board, the National Research Council, and the Board of the Environmental Research Institute of Michigan.

General Schriever with models of missiles he helped to build.

Reflections on Air Force Research and Development

Participants	Air Force Service
Lt. Gen. James H. Doolittle	1917–1946
General Bernard A. Schriever	1931–1966
General Samuel C. Phillips	1942–1975
General Robert T. Marsh	1943–1984
Dr. Ivan A. Getting	1945–Present
Dr. Richard H. Kohn, Chief, Office of Air Force History	

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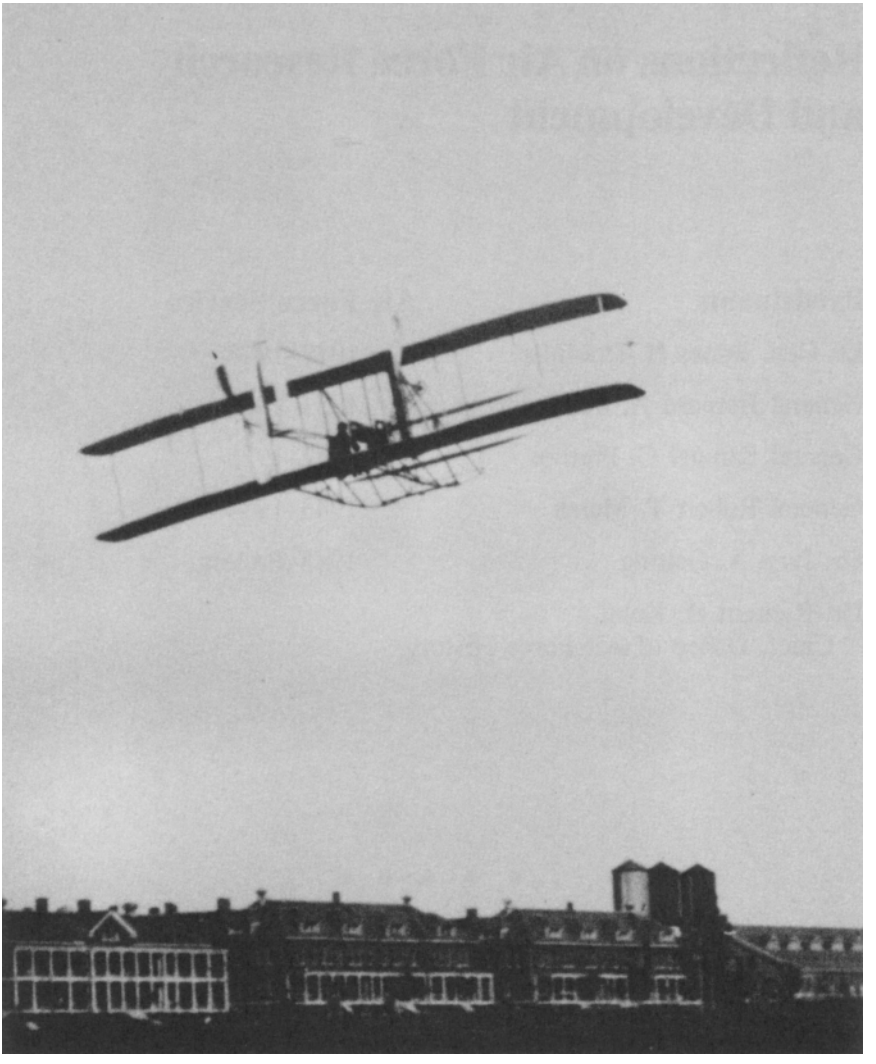
Kohn: The purpose of our interview this morning is to discuss the research and development process in the Air Force, all the way back to its origins: why the Air Force conducted research and development in a certain way, what influenced that process, and how the process has evolved over time. Our goal is to try to get a sense of the successes and failures of the process. We hope we can learn from going backwards and understanding the evolution of a process or a set of activities in the Air Force.



A Wright 1909 Military Flyer in the Military Flight Trials at Fort Myer, Virginia.

The Early Years

The best place to start is to ask how the Air Force's predecessors did research and development back in the 1920s and 1930s. Did they devote much in the way of people or resources to the process and was the leadership interested in research and development?

General Doolittle, you were engaged in research and development in those years as a test pilot and through your scientific studies. Were you alone or were there people to help you?

Doolittle: Not at all. There were people who appreciated the importance of research and development, but the lay pilot did not. I had the advantage of scientific and engineering training at MIT [Massachusetts Institute of Technology]; I had the pilot's background and the technical background. The average pilot, however, didn't have a great deal of interest in research and development.

Phillips: The average pilot in those years had a great deal of interest in the final product: the airplane.

Doolittle: Many of them were barnstormers. They bought excess military airplanes that were sold very cheaply after the war. They would pick up a Jenny or a Standard[7] at a very low price and then they would travel around the country doing what they called "barnstorming"—carrying passengers and putting on exhibitions. It was a hand-to-mouth existence.

Kohn: How did the Air Service and the Air Corps go about trying to develop more capable airplanes, General Doolittle? Did they do it alone? What was our relationship with the NACA[8] [National Advisory Committee for Aeronautics] and with industry in the 1920s and 1930s?

Doolittle: I think we were just beginning to realize the importance of getting people into the Air Service who had a technical background and could marry the pilot and the aeronautical engineer.

Kohn: Those people must have been hard to find.

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[7] This refers to the Curtiss JN–4 "Jenny" and SJ–1 "Standard" airplanes.

[8] NACA was established by the Naval Appropriations Act of 1915, ". . . to supervise and direct the scientific study of the problems of flight, with a view to their practical solution."

Doolittle: They were.

Getting: When I went as a freshman to MIT in 1929, the chairman of the Aeronautics Department I believe was named Jerome [C.] Hunsaker.[9] He explained to the freshman class that the total expenditure in the aircraft industry in 1929 was below that of the total sales of straight pins in the United States.

Kohn: So the industry was a very small and isolated enterprise.

Doolittle: That's correct.

Marsh: Evidently the Air Service and Air Corps recognized the importance of it because tremendous strides were made by the late 1930s. At Wright Field[10] [Ohio], for example, they put together a cadre of engineering-type people.

Kohn: Didn't the Air Service and Air Corps approach the aviation industry with a requirement, saying in effect, "this is the kind of airplane we want—do you think you can build it for us?" Was there not a decision early on to have industry build the Army's aircraft, as opposed to the Army manufacturing airplanes itself?

Doolittle: The problem was that aviation was a science and an industry that was very new, and developing very rapidly. It was difficult to keep everybody in step. Ivan, coming out of MIT, had a background in aeronautics. The pilot had no engineering knowledge whatsoever; thus the two spoke different languages. I was one of the few who spoke both languages at that time.

Kohn: The Air Service and Air Corps put considerable effort into air races and competitions. Was there a research and development purpose in that activity?

Doolittle: It was for two purposes: one was research and development, the other was to bring aviation to the American public.

Kohn: Do you think it succeeded in both ways, General Doolittle?

Doolittle: To some degree.

Kohn: What would you say were the greatest strengths of this system in the 1930s? The Air Corps did, after all, develop the B–17. Some very capable aircraft were produced by industry at that time.

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[9] Dr. Hunsaker served as chairman of NACA from August 1941 to October 1957. He was succeeded in that position by Doolittle.

[10] An airfield near Dayton, Ohio. In October 1927 the Air Corps' Materiel Division which moved to Wright Field from McCook Field.

Right: **"Jimmy" Doolittle after winning the Bendix Trophy in 1931.** ***Below:*** **Army ground crews load air mail sacks on a Keystone B–2 bomber.**

Doolittle: Yes, there were zealots then as there are now, people who really believed in aviation and some of them were very knowledgeable.

Marsh: Ivan, when you graduated from MIT in 1933, was Wright Field beginning to take shape and had it earned any kind of a reputation as a center for aeronautics?

Getting: Well, I can't speak from personal knowledge until about 1940. In 1940, I got to know the people at Wright Field because the war was around the corner, and I was associated with the Radiation Lab at MIT, part of the NDRC/OSRD [National Defense Research Committee of Office of Scientific Research and Development]. We had many close relationships with Wright Field, and it was by then an ongoing organization.

Kohn: You were a test pilot in the latter part of the 1930s, General Schriever; was there a feeling in those years that the Air Corps' aircraft were as good as those of other countries, and that its process of development was good?

Schriever: When I went through the flying school in 1932–33, we hadn't advanced a hell of a lot beyond where we were in World War I. We were still flying biplanes, open cockpit Keystone bombers. It is true that some of the equipment was being developed, but the Air Corps was quite short of money. The airplanes certainly were way behind where they should have been from a technology standpoint. What really triggered developments in the 1930s was the debacle of the Air Corps airmail experience in 1934.[11] We lost a lot of airplanes and a lot of people. Subsequent to the airmail debacle, in which I participated, President Franklin D. Roosevelt made Bennie Foulois [Maj. Gen. Benjamin Delahauf][12] the scapegoat. But, he [Roosevelt] did appoint the Baker Board,[13] which came up with recommended measures which really started the modern Air Force.

Wright Field did a tremendous job, but they just didn't get the funds. The Army was really not supporting air except for reconnaissance purposes, as

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[11] From February 19 to June 1, 1934, the Air Corps was commissioned to fly the air mail. Twelve pilots were killed during this time. This episode stemmed from President Franklin D. Roosevelt's decision that government mail contracts had been arranged through fraud and collusion. He cancelled contracts with the commercial airlines.

[12] Foulois was Chief of the Air Corps, U.S. Army, from December 1931 to December 1935.

[13] A War Department Board, headed by former Secretary Newton D. Baker, convened in April 1934 to study the operations of the Air Corps and its proper relation to civil aviation. Reporting in July, the Baker Board rejected calls for either a unified defense department or an independent air force. It also denied most claims for air power with the statement: "Independent air missions have little effect upon the issue of battle and more upon the outcome of war." However, the Baker Board did recommend creation of a GHQ Air Force made up of air combat units and capable of operating either independently, or in cooperation with ground forces.

artillery spotters and things of that kind. If the airmail hadn't come along, we would have been in one hell of a shape, in my opinion, for World War II. When I went to Wright Field in 1939 and was a test pilot for a little over a year, we were flying practically every airplane that we operated in World War II. Those all came along, almost all of them, after the airmail. We had a couple of B–17s at Wright Field at that time that we were test flying. But, the thing that really triggered rapid development in aircraft during the 1930s was the crisis that came out of the airmail episode.

Kohn: How was NACA involved?

Schriever: The NACA was involved very intimately with the Air Force, but it was largely a research organization. They wouldn't have thought, for example, of doing a space shuttle and operating a shuttle. They were strictly research, but the Air Force and NACA worked very closely together. The Air Force had members on all the committees of the NACA, so it was a very, very close-knit sort of a thing.

Kohn: If you were to talk about the institutions or the people in the 1930s that developed aircraft—I am thinking essentially of the NACA, the Air Corps, and industry, as the three major institutions heading in that direction. . .

Doolittle: They were, but they didn't always work together in unison. Each one had their own ideas and ideals. I think one of the things that caused delay was the lack of cooperation and coordination between the different agencies that were interested in aviation. And there was nobody to bang heads together.

Phillips: The B–17 is about to celebrate its 50th birthday. I'm not sure whether it is the 50th birthday of the first flight[14] or introduction into the Air Corps, but I'm curious about the origins of the B–17. Did it come from the Air Corps as an initiative and then Boeing [The Boeing Company] contracted to do the work, or did some of the initiative come on the industry side? Do you recall?

Schriever: I don't recall, but remember the key individuals of that period—Generals Arnold,[15] Mitchell, Frank Andrews—and you remember those runs where we sank a couple of naval vessels after World War I from those old bombers. There was a very strong bomber orientation to the Air Corps, and

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[14] The first flight of the XB–17 (model 299) was on July 28, 1935. The first thirteen B–17s were delivered between January and August 1937.

[15] Henry Harley "Hap" Arnold (1886–1950) was Assistant Chief of the Air Corps in January 1936 and became Chief of the Air Corps in September 1938.

William "Billy" Mitchell (1879–1936) was court martialed by the Army in October 1925 because of his outspoken beliefs in air power. He resigned his commission in February 1926 and spent the next ten years writing and speaking on the capabilities of air power.

Frank M. Andrews (1884–1943) was the commander of General Headquarters Air Force from March 1935 to March 1939.

I'm quite sure that the specs [specifications] for the B–17 were jointly developed.[16] I'm not sure of this. I'm just surmising because I knew the people involved. Boeing probably made some proposal and the Air Force people worked with Boeing on the design. I'm quite sure that is how it evolved. Do you remember, Jimmy?

Doolittle: That's right.

Phillips: That was probably true also of the fighters that were developed in that period, like the P–39.

Schriever: I can only speak from personal experience from the time I arrived at Wright Field in 1939 as to how the Wright Field people worked with the industry. I would say, Jimmy, at that time we were working very closely with the industry. There was a good feeling of cooperation between the industry and the Air Corps, not the adversarial one that has developed over the last ten or fifteen years—which exists today—and I think is very negative really to getting on with the main job.

Marsh: Do you know when that process began at Wright Field? Was it early in the 1930s or in the mid-thirties?

Schriever: Well, that relationship between industry and the Air Corps started at McCook Field where Jimmy was after World War I. He could speak of that earlier period.

Doolittle: There was a very good relationship between the Air Service and the industry. There was, of course, keen competition in the industry.

Phillips: Back in that period, which predated my Air Corps and Air Force service, a lot of initiatives were taken to demonstrate things like air refueling and long-range flight and a lot of the work you did, Jimmy, in developing all-weather flying instruments. Did those kinds of initiatives come out of Wright Field, from Air Corps officers in the main?

Doolittle: Yes, but they moved very slowly.

Kohn: The original ideas, General Doolittle, came from the technical people in the Air Service and then were translated into experimentation. At McCook Field was there discussion of ideas at their early stage between Air Service officers with industry or NACA? What General Phillips is perhaps asking is, did you on your own at McCook Field, come up with these things and say, "Let's try this?"

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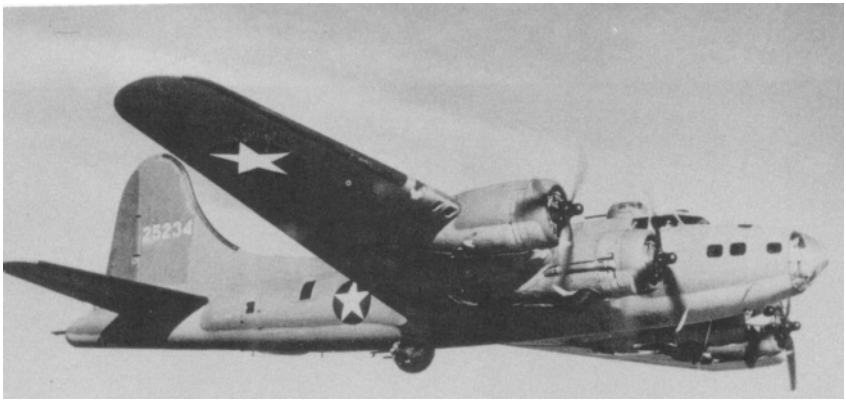
[16] Actually, the Air Corps specifications called for a multi-engine bomber. The B–17 was an outgrowth of the Boeing 299 bomber initiative.



The Boeing B–17F Flying Fortress typified the advances made in long-range bomber technology between the wars.

Doolittle: No, there was close cooperation. There were also very honest differences of opinion that sometimes kept the gears from going as smoothly as they should.

Getting: Jimmy, you are talking about the worst period of the worst [economic] depression this country went through. I suspect that money was not readily available for a great deal of things. Is that true?

Doolittle: That's right.

Schriever: That's exactly right. As a matter of fact, we once had a 10 percent cut, and we had salary freezes. Those came right after the Hoover Administration, when Roosevelt came in. If you look at the officers in the Air Force, and you look at the titans of industry—the "Dutch" Kindelbergers [J. H. Kindelberger], the Martins [Glenn Martin], the McDonnells and so on down the line—you can understand that these people worked together, but there were differences of opinion. They all had strong views. We had some very good technical people in the aviation industry. You could hardly tell the difference between the key Air Force people and these key people, at least from where I was sitting.

Doolittle: That's what I meant by "cooperation."

Women contributed greatly to the war effort by working in aircraft manufacturing plants. An inspector, above, checks the tail gunsight instrument of a Boeing B–17 in a Boeing Aircraft Plant.

World War II

Kohn: Did research and development change substantially when we entered World War II, or did the effort just expand?

Doolittle: One of the big changes in World War II was that the automobile industry got into the aviation business. I happened to be in the middle of that; my job was to marry the two agencies when neither one of them wanted to get married. The aircraft industry didn't want the automobile industry to get into their secrets, lest they be competitors when the war was over; the automobile people didn't want to do piecework because their forte was mass production. It was anything but smooth-running at first. Finally, people like Henry Ford and the others realized this was something of great national interest, so they threw themselves into it and did a superb job. But to go from mass production to piecework was very difficult for the automobile people.

Kohn: General Doolittle must leave us now, but I want to thank him very much for being with us this morning.

Did the universities become involved in aeronautical R&D, Dr. Getting, when the war came? You were at MIT then, weren't you?

Getting: I was at Harvard. I was among the first five or six employees of the Radiation Laboratory at MIT, since that was just down the street and there were no moving expenses involved.

In any case, a year before we went into the war, Vannevar Bush, at the request of the President, established what was first called the National Defense Research Committee which later became the Office of Scientific Research and Development [OSRD]. It mobilized practically every active scientist, physicist, chemist, and every other scientific specialty in the country, and also picked up thousands of engineers who had been unemployed, at least in their professional work for ten years, because of the same depression that caused the lack of support for research in the aircraft business. So I think we must remember that when the war approached, there was a dramatic change in availability of support in the form of money. The Radiation Laboratory, which did not exist until October 1940, grew into an organization of several thousand scientists and engineers in a matter of a year or so. OSRD had less effect on the aircraft industry, that is engines and airplanes, because both were well-established industries and were able to step up to the mark. OSRD was principally effective in introducing new concepts of warfare, particularly in the areas of navigation, radar, and communication.

Dr. Vannevar Bush directed the wartime Office of Scientific Research and Development and later the Joint Research and Development Board.

Phillips: Where did OSRD reside in the government structure?

Getting: It was an independent agency reporting directly to the President, and it was funded directly by Congress by appropriations. But as it grew rapidly, it developed a close liaison with the services, something like NACA with a steering committee of an admiral, an Army general, and an Army Air Corps representative. Money started to flow then from the Army and from the Navy into OSRD.

Kohn: How did the Army Air Forces go about determining when to freeze development in the war on a particular airplane or a particular portion of it and begin on production?

Getting: Let me comment on that. You must remember that many of us were quite young and not necessarily directly involved when Roosevelt took us into the war (I use that term with some freedom). But he did come out with a policy of producing 50,000[17] airplanes a year, which was ridiculous in the minds of

[17] On May 16, 1940, President Roosevelt called for an air force of 50,000 Army and Navy planes, supported by an annual production capacity of 50,000 military planes.

Approximately 7,000 Boeing B–17s were produced during World War II. This photograph shows fuselage sections under assembly.

most people. That was such a large increase, but industry got going very rapidly, as you know. Santa Monica [California] was practically built up around Douglas Aircraft. If you go there today, you'll see all these rows and rows of small houses that were built there for housing the workmen who were brought in from everywhere. However, by the same token, this rush to go ahead with the aircraft also made it difficult to introduce innovations and changes. I can tell you that when we tried to put radomes[18] on the airplanes in World War II, we had an awfully difficult time with the Wright Field people because they were so focused on production. Now I'm making that statement to try to get some reaction from Bennie.

Schriever: When the war started, I was at Stanford University and things were so screwed up that Ralph [L.] Wassell[19] and I stayed out there until June before we received our orders. Can you imagine that? The war started in December and we were going to school for six months. I went overseas and I stayed overseas for almost three and half years, so I didn't get involved in what was happening here in the States.

However, in connection with the question, I don't think there is an answer that fits the question; development not only continued during the war but it accelerated. On the other hand, those of us who were on the operational side weren't interested in something a couple of years downstream. The issue was, what can you do for me today?

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[18] A radome is a protective dome or domelike covering for a radar antenna and, sometimes for other radar equipment, such covering being pervious to radio-frequency radiation.

[19] General Schriever is referring to a schoolmate of his, 1st Lt. Ralph L. Wassell (1910–).

While we're looking at the production side, we were also quite innovative in the field, as a matter of fact. I became chief of maintenance of the Fifth Air Force after a tour in B–17s. I stayed overseas on the service side so I was involved in some of the innovative things that we did. We put 50–caliber guns in the nose of the B–25. We did that in Australia. Things like that were going on all the time. In the electronics area, we had a whole revolution of electronics that was stimulated by the war: nuclear weapons, jet engines, rockets. Development continued, although some of it didn't get into the war. We were looking toward improved performance all the time.

The big job, certainly at the start of the war, was getting into production. Industry did a fantastic job. They developed synthetic rubber during the war, which was aimed to a very large extent at aviation, and 100–octane gasoline, which we had to have for our engines. So a lot of things occurred during the war that, in my opinion, really triggered the technological revolution that has been with us ever since.

Kohn: When you talk about the revolution in electronics, General Schriever, what specifically do you have in mind?

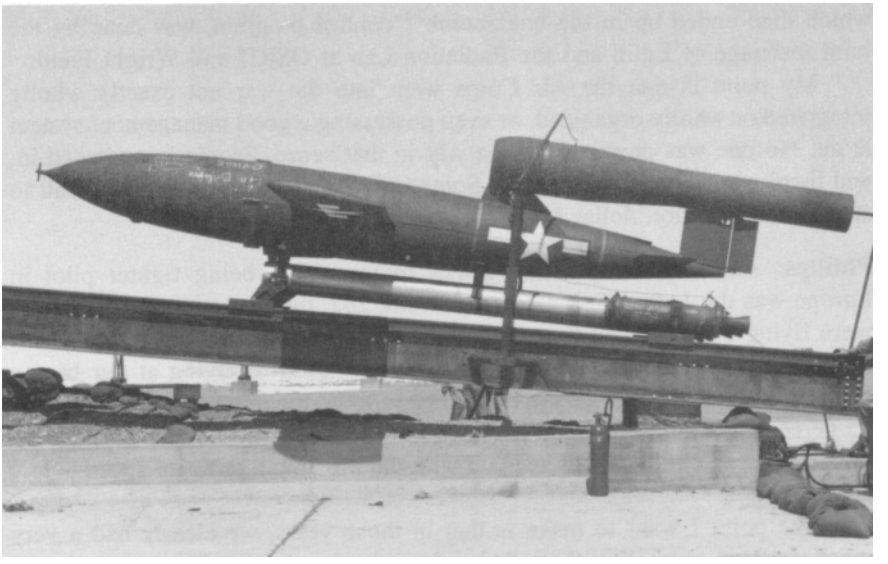
Schriever: Radar. I'm not into electronics. I'm an aeronautical engineer, not an electrical engineer, but I know the end results.

Phillips: Let me give you an example. During World War II, I was a fighter pilot in the Eighth Air Force, having come on active duty in 1942. The fighter base that we were on was Huntingdon, in England, and that was also a bomber depot base, B–17s. In 1944 some B–17s were converted to be radio-controlled drones and guided by B–17s as directors. I learned about those partly because my squadron wound up escorting some of those missions across the North Sea to dive those drones into submarine pens on Helgoland.[20] In 1944, the terminal guidance system on that was television. The director had a little five inch cathode ray tube, which was the receiver display (and of course the drone had a camera in its nose). Now there was an example of a rapidly developing revolution in electronics. I saw it from the operations end.

Getting: I'm glad you brought this subject up, because it ties together three things: one was that the Air Force at that time had a surplus of B–17s and B–24s, and General Arnold wanted to get rid of some of those so he could get the longer-range B–29s for the Pacific. So he introduced what was called the Willie Orphan and Willie Mother Plan.[21] They were executed in the field just

[20] Helgoland is located at the mouth of the Elbe River, Germany.

[21] This plan was better known as "Weary Willie," a name applied to certain B–17 or B–24 bombers loaded with TNT and piloted by radio control after becoming airborne. The "mother" plane directed the bomber to crash into its target.



The JB–2 was an American copy of the German V–1 pulsejet missile. Some 1,300 JB–2s were built during World War II.

like Bennie said, by a group of Army Air Force officers, Navy people, and a few Wright Field people—civilians who were put into uniform.

It is not generally known but the oldest son of the Kennedy family [Joseph, Jr.][22] was killed when one of these drones blew up before the crew could parachute out of it. The net result of that accident was that General Arnold declared a halt to that program and asked for professional help from Vannevar Bush of OSRD.

In my opinion the Air Force was not well organized at that time to do research. No reason why it should have been. It was not an air force; it was the Army Air Forces. It did not have control of its own development. It received communications from the Signal Corps, machine guns from the Army Ordnance Corps, and there was no centralized Air Staff in control of everything like Bennie Schriever had later. So it was a piecemeal process and General Arnold for that reason gave the job of coming up with the solution to these Willie Orphan planes to Gen. Grandison Gardner,[23] who was the commander of Eglin [AFB, Florida]. Eglin was not a development center, but Arnold had no place else to turn to. So the development of that program,

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[22] Joseph Kennedy, Jr., was the eldest brother of President John F. Kennedy.

[23] Maj. Gen. Grandison Gardner (1892–1973) headed the AAF Proving Ground Command from 1942 until 1945.

which then ended up in the buzz-bomb[24] control program, was done by the joint marriage of Eglin and the Radiation Lab at OSRD and Wright Field.

My point is that the Air Corps went into the war not exactly wholly integrated or wholly organized, or even possessing a good management system at all. No one was prepared for the war in that sense. People just pitched in, and there was a lot of informality. Sometimes it only took a telephone call to start a multi-million dollar program.

Phillips: Another example that comes to my mind, being fighter pilot in Europe was the *Luftwaffe* Messerschmitt Me 262, the first operational jet. We were flying P–51s at that time. It couldn't have been more than a few weeks after the appearance of the Me 262s that we started receiving at our base a special fuel which could be put in the P–51s to up the power on the engine by 25 percent. With that fuel additive that went into the 100–octane gasoline we were using, we could almost keep up with the Me 262 in terms of speed at low altitude.

The point I want to make is that in those years, we clearly had a very quick-reaction capability; there had to have been some machinery here in the States that was recognizing a new enemy threat and developing something quickly, and getting it overseas. Of course one of the prices we paid was that if you actually used that high power with that special fuel, the engine was good for about one mission and then you had to change the engine. But in any case, it was a quick reaction to the appearance of a new threat.

Getting: In regard to quick reaction, a war is a war. World War II was a war for survival and everybody pitched in and paid very little attention to red tape and rules and regulations. In fact, I doubt if hardly anybody knew they existed. The accounting people and the financial contracts people were chasing like mad to try to catch up and patch up all the problems and make them legal after the fact.

Schriever: I don't remember reading any regulations!

Getting: There was a British branch of the Radiation Laboratory with about 300 scientists in it and there was a weekly teletype from the Pentagon, and if they needed new parts for radars or the bombing system or anything like that, for the MEW [mobile/microwave early warning],[25] or for the invasion of Normandy, inside of a day or two the parts were available in England for installation. So there were a lot of parallel communications, works, supplies—as Bennie said, "What regulations?"

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[24] "Buzz bomb" was the nickname for the World War II German V–1 (FZG–76) aerodynamic (cruise) missile. The American copy of the V–1 was designated JB (jet bomb)–2. By 1946 nearly 1,400 of the latter were produced.

[25] MEW is a designation for a high-power, long-range, early warning radar.

Let me change the subject slightly, to say that there existed under Secretary of War Stimson [Henry L.][26] and under General Arnold, in Washington, another very effective organization which does not get adequate credit. That was the office of Dr. Edward Bowles. Ed Bowles had been a professor at MIT, was the first secretary of the Radar Committee of the NDRC, and then came into the Pentagon as the special assistant to the Secretary of War Stimson. He was what you might call an "oddball fifth wheel." He could write letters extremely well, and by order of the Secretary of War he was to introduce new concepts and new technologies and new equipment, particularly communications and radar, into this big organization called the Army Air Corps, which was interested in "what am I going to fly today?" It was very, very difficult, but Edward Bowles was able to accomplish it.

He surrounded himself with a lot of good people. I must mention Dave Griggs[27] who became the righthand arm to Ed Bowles and to General Arnold in flying back and forth and carrying new equipment to the Eighth Air Force. Griggs flew with the pilots over Germany, dropping bombs with radar assist and navigation assist.

My point is that it was necessary to bring the civilian scientists, new equipment, and new ideas into the uniformed forces. This was one major innovation of World War II, although it had existed a little bit in World War I and even in the Civil War. But from my personal knowledge, since I was also a member of that office, among my many hats, it was an extremely effective way of getting around the sort of rigid structure that any military organization has to have for purposes of discipline. You could go from Ed Bowles' office to Jimmy Doolittle when he was running the Eighth Air Force, or you could go anywhere else in the country and not break any rules or regulations. You were able to get people to know the problems, to get them to work together, to pull in the same direction, and get the job done. I think that was an important contribution of World War II.

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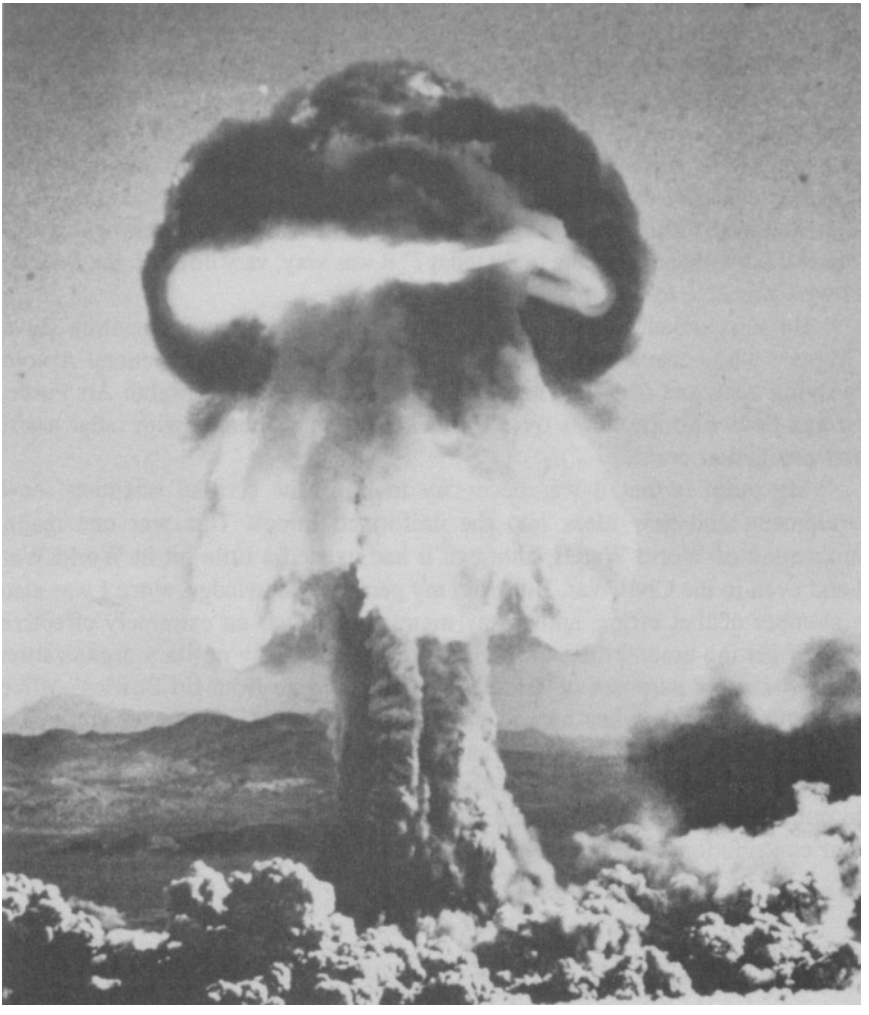
[26] Stimson (1867–1950) twice served as Secretary of War: for President Taft, from May 1911 to March 1913, and for President Franklin Roosevelt, from July 1940 to September 1945. In this position he presided over the expansion of the War Department and Army during World War II, was a leader in seeking the enactment of legislation for compulsory conscription, and was closely involved in the decisions to evacuate Japanese Americans and aliens from the coastal regions and to use the atomic bomb on Japan.

[27] Dr. David Griggs flew with these missions as a scientific observer.



Thermonuclear weapons changed the face of war forever.

Post World War II

Schriever: When the war ended, everybody went back to their universities. How would we continue this kind of relationship with the scientific community? Hap Arnold saw the necessity of continuing the relationship very, very clearly. In this time period, I was involved as a staff guy running around doing the dirty work. Hap Arnold in essence said, "We have to continue to maintain a very close relationship with the scientific community. We are in a technological revolution. We are never going to fight another war like we fought the last one. We have to marry with the scientific community." My involvement was an office called Scientific Liaison; you may remember that, Ivan. I was in charge of that office when it was created. We did the staff work for such things as the Scientific Advisory Board.

Getting: It was first the Scientific Advisory Group, then the Board.

Schriever: Yes. I attended the first meeting of that. Unfortunately, I was sitting so far in the back row that I'm not in the picture. Nevertheless, it was the Scientific Advisory Board, which we have today. It was Dr. Theodore von Kármán[28] and his study effort, *Toward New Horizons*, which formed the platform which has allowed the Air Force to continue a very close relationship with the scientific community. Arnold, I think, was one of the most farsighted persons that I have ever known. I had the good fortune to know him well because I was a young second lieutenant under his command when he was a lieutenant colonel at March Field in 1933. So I did know him quite well. He knew what was necessary, and I think we owe a great deal to him for the very close relationship that the Air Force has with the scientific community, closer than either the Army or the Navy.

Kohn: Was one of Dr. von Kármán's concerns the organization of the R&D process? In 1945, 1946, and 1947, the Army Air Forces were demobilizing but also realizing that a relationship with the scientific community would have to continue. How did the Army Air Forces arrange itself to give this business a boost and to keep it going?

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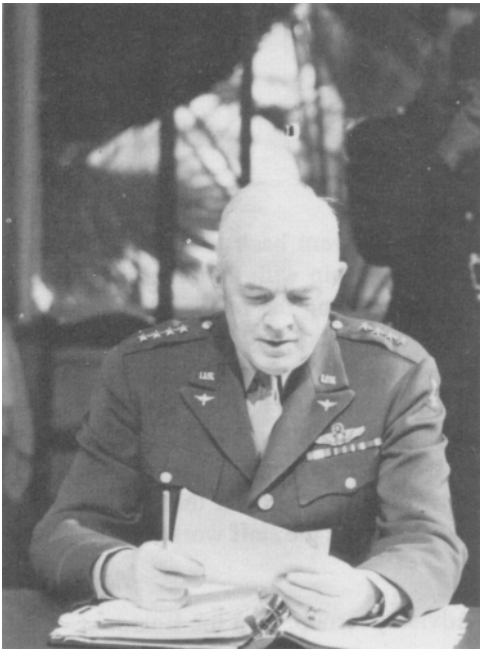
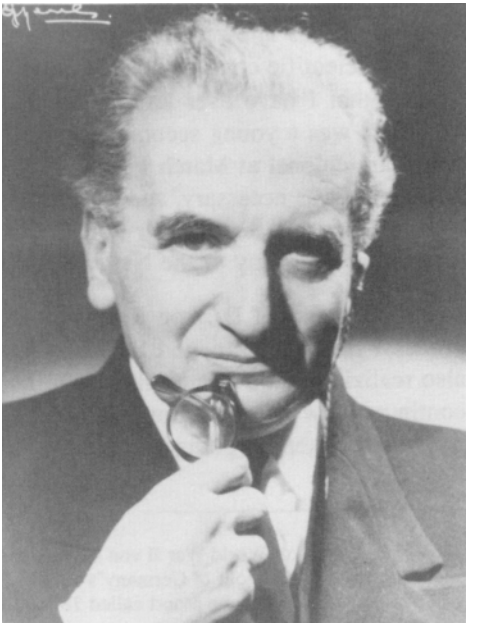
[28] At the end of World War II von Kármán selected several of the nations leading scientists to accompany him on a tour of Germany's aircraft and rocket facilities. Based on this survey, the group issued a multi-volume report called *Toward New Horizons* that suggested new avenues of research and development in aeronautics and rocketry.



General Henry H. "Hap" Arnold was an ardent advocate of research and development, particularly after being goaded by the radical advances Great Britain made with turbojet development.



The eminent Hungarian aerodyanmicist Dr. Theodore von Kármán was asked by General Arnold to get the "best brains available" for the Army Air Forces' research and development effort.

Schriever: Let me comment first and then I know Ivan, who was very much involved on the scientific end, would also like to comment.

The creation of the Scientific Advisory Group was definitely General Arnold's work with von Kármán. The creation of the Rand Corporation—I don't know whose idea that was originally.

Getting: Arnold's and Bowles's.

Schriever: The need for an organization within the Air Force to manage and push forward technology was recognized; there was the Ridenour study, the Doolittle study—these all occurred during the period between 1946 and 1949.[29] Eventually what evolved was the creation of the Air Research and Development Command.

You can't change things that rapidly from an organization like the Air Materiel Command [AMC], which controlled literally hundreds of millions of dollars—I mean they were the power of the Air Force—and break out the research and development activity from an organization that had the strength that AMC had. It was not easy.

Ivan was very much involved in these studies. As a matter of fact, he was in the Pentagon, and I worked for him for a year when he was Assistant for Evaluation. Then in 1951 we changed it to the Development Planning Office. All of that was an evolutionary process of changing organization and management policies and procedures to give greater strength to the technical aspect of our decision-making. Ivan, you were involved in all that period as well as I was.

Getting: I was certainly involved in a variety of ways. One was, as Bennie Schriever said, with General Arnold and von Kármán establishing the Scientific Advisory Board. I did get in the picture, although only on one edge, but at least I did get in the picture.

But you must remember that when the war was over there was a demobilization of the scientists in OSRD. There was also a demobilization in the armed services, a surplus of equipment and a lot of people leaving. Right after the war was over, within a year or two, there was the reorganization of the Department of Defense [DOD] and the creation of a new Air Force as an independent service. At that point, there were many serious questions of organization.

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[29] The Ridenour study, completed in September 1949, was led by Louis N. Ridenour, Jr., who served as the first Air Force Chief Scientist from September 1950 to August 1951. The study consisted of a group of civilian scientists who recommended that the Air Force establish an organization to promote aeronautical research and development. In November 1949 the Anderson study, prepared by an all-military panel under Maj. Gen. Orvil A. Anderson of the Air University, concurred with the Ridenour Committee's findings and also suggested representation for R&D on the Air Staff. General Doolittle served on both of these committees and was so influential that the Anderson study was mistakenly attributed to him.

As I pointed out, the Signal Corps—not Wright Field—had supplied all the ground radars, all the ground communications. The Aberdeen Proving Ground [Maryland] and the Frankford Arsenal in Philadelphia were responsible for machine gun designs for the Army. What happened, as you know, was that the Watson Lab in Newark, New Jersey, was split-up and part of it was transferred to Rome, New York, and parts of the Radiation Lab were broken off and put into the Cambridge Research Lab [Massachusetts] to try to keep some capability for the new Air Force.

At the time Bennie and I were working together in the Pentagon, the Army Ordnance was still providing machine guns. That was in 1950. So this transition from an Army Air Forces as a part of the Army to the independent, stand-alone Air Force took at least five years. In fact, communications R&D [research and development] in the Air Force was nonexistent in that period. The single-sideband communication[30] for SAC [Strategic Air Command] was introduced by Curt LeMay [General Curtis E.][31] when he was running SAC, because he was an independent S-O-B and didn't pay any attention to the rules, either. He was a Ham radio operator.

So the Air Force didn't get fully organized until Bennie Schriever took over ARDC [Air Research and Development Command]. But in that period there was a good deal of confusion and R&D in the Air Force went down. In fact, in 1947 I resigned from the Scientific Advisory Board [SAB]. I was then chairman of the radar panel of the Research and Development Board, which was trying to pull together the three services, which were divided as a result of the split-up. Be that as it may, things got very bad in research in 1947–48. One day von Kármán met me in the hall and said, in his Hungarian accent, "By God, I quit SAB." I said, "Because you weren't doing anything?" He turned to me and said, "*Schweinhund.*"[32] That meant I was a member of the family, see.

I have just reread, before coming here, the history you prepared on the SAB. That comes true very clearly in the way you recorded the history; R&D did poorly in 1947, 1948, and 1949. Ridenour was sent up by General Vandenberg to do a study of R&D in the Air Force. Jimmy Doolittle, who was not a member of the SAB at that time, was a member of that committee; that was a pretty important committee. That was the report Bennie Schriever was

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[30] Single-sideband is "a system of carrier transmission in which one sideband [frequency] is transmitted and the other suppressed." [John D. Bergen *Military Communications: A Test for Technology*, Wash, DC: Center for Military History, 1986, p 495.]

[31] General LeMay (1906–1990) was Commander-in-Chief, Strategic Air Command, from October 1948 to 1957. LeMay turned SAC into the world's most powerful nuclear force. In the days before the deployment of guided missiles, he developed SAC's policy of constant alert, keeping some bombers aloft at all times, ready to respond to a Soviet attack.

[32] *Schweinhund* is an insulting German epithet, meaning "filthy fellow," formed by combining the words hog and dog.

pointing to. It said in so many words, as General Arnold and everybody else had, that the Air Force's future would depend on technology and on scientific research and development. Burying it under AMC was not going to bring about such an end product. It was overwhelmed.

Kohn: Was that organizational struggle within the Air Force a good part of the story (General Schriever, you also alluded to it)—trying to separate research and development from procurement, and then from logistics?

Schriever: It was a hell of a struggle. There was lots of blood on the floor; you are damn right. As a matter of fact, Jim Dempsey [Maj. James R.],[33] who was here a while back, was in the Pentagon at the time, and Teddy Walkowicz [Lt. Col. Thaddeus F.],[34] and we had about three or four other younger officers. I guess we were the young Turks of the period at the fighting level. We had the support at the top with first Arnold's leadership and then we had von Kármán and people like Ivan and other scientists who were working through the SAB, the Ridenour Report. Jimmy Doolittle was very active in all of these studies and analyses with respect to how we should structure ourselves best to bring technology into the forefront, into the decision-making process.

It was a tough struggle, and we didn't win it all until we created ARDC in 1950. It took us another eleven years to get the acquisition part because, at least in my opinion, from concept to acquisition is a continuous process. You go from research, to applied research or exploratory development, to advanced development. You make a decision then, finally, to put some of that technology into a weapon system. It is a smart thing now to change it and give it to another command, which now controls all the money. So we had another fight for ten years, but we are not at that period yet. Finally, with the creation of the Air Force Systems Command (AFSC),[35] we put together the whole thing so that one command had the overall responsibility to get a system into the inventory. That doesn't mean that other commands don't work along, like the operating commands, the [Air Force] Logistics Command, the [Air] Training Command, and so forth, all working together in the planning process, and getting ready for the operational inventory. It was a long struggle. As a matter of fact, it still continues. This is not something that goes away.

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[33] Lt. Col. James R. Dempsey (1921–) was an Air Force officer from 1943 to 1953. He was the Atlas Program Director at the Convair Division of General Dynamics from 1954 to 1957. He became president of Convair in 1958 and served as president of General Dynamics Astronautics from 1961 to 1964.

[34] Lieutenant Colonel Walkowicz (1920–) was the Executive Secretary to the Scientific Advisory Board from November 1948 to November 1950.

[35] Air Force Systems Command was created in April 1961.

Getting: When the Ridenour Report came out, it gave great emphasis to the need for identifying research and development as a major activity of the Air Force with direct representation at the Deputy Chief of Staff level, which it hadn't had before. There was a director of research who reported to the Deputy Chief of Staff for Materiel and the whole AMC organization reported, as it were, through the Deputy Chief of Staff for Materiel. I don't think Ridenour's Report would have gotten anywhere had it not been for the fact that Jimmy Doolittle, who was sitting here a little while ago, was at that time a special advisor to both the Secretary of the Air Force and to the Chief, General Vandenberg. It was Jimmy's personal salesmanship. There is another rule that you'll learn in the Air Force: you've got to have somebody in the Pentagon to walk up and down the halls and protect your vested interest at all times. In this case, on this item, it was Jimmy Doolittle, who was held in the highest regard by both the Secretary and by the Chief, who sold General Vandenberg on the need for this reorganization. There were two strong characters just before this was put in, or part of this structure established: a Deputy Chief of Staff of Development to identify that it was coequal to Materiel (that was Maj. Gen. Gordon P. Saville[36] who was brought up from the Air Defense Command, which was part of Continental Air Defense Command in Long Island [New York] at that time.) He was made the Deputy Chief of Staff/Development. In my opinion General Saville was one of the great Air Force generals of all times; he ranks up there with other people we have mentioned.

The Deputy Chief of Staff for Materiel was K. B. Wolfe [Lt. Gen. Kenneth B.].[37] Both of these people were completely convinced, and honestly convinced, that each of them was right: that you shouldn't split up this process from research to maintenance to procurement and all. That was K. B. Wolfe. Gordon Saville was equally convinced you would never get there from here if you did that. So these two gentlemen were people that we had to work with for a long time. They both finally decided they couldn't trust the survival of the Air Force if one or the other left first, and so they both retired on the same day![38]

I do want to point out that what Bennie Schriever said was very correct: that in the five-year period between the end of the war and 1950 there occurred a transition from war to a low point and then to a recovery period that came about just about the time that the Korean War began and brought about another stimulus to military spending. In fact, a year before 1950, the Russians had

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[36] General Saville (1902–1984) was Deputy Chief of Staff for Development at USAF headquarters from January 1950 until May 1951.

[37] General Wolfe (1896–1971) was appointed Deputy Chief of Staff for Materiel at Headquarters USAF in September 1949 and served in that position until June 1951.

[38] Actually, Generals Wolfe and Saville retired one month apart, on June 30 and July 31, 1951, respectively.

blown up their A-bomb. So, in the period of 1948, 1949, 1950, there was a much greater emphasis on military research and development and the beginning of the jelling of the Air Force as an organization instead of a part of another organization. There was also a greater concern about the security of the United States against Soviet bombers coming in with missiles on the one hand, and China coming in on a war in Korea on the other hand—the possibility of World War III. This was the period that Bennie and I were involved together in doing what we thought were great things.

Kohn: You mentioned that in the 1920s and 1930s one of the great problems was lack of money. I assume the bottom fell out of funding with the end of World War II and then in 1948, 1949, and 1950, it began to increase again. Did you see that influence in that five-year period?

Schriever: While Louie Johnson [Louis A.][39] was Secretary of Defense, we couldn't afford more than a $13 billion budget. I think that was for the whole Defense Department. Then Korea hit and Louie Johnson was fired. I have forgotten how high the budget got in connection with the Korean War, but he was talking "$13 billion is all the country can afford." Now that was the period just after World War II, 1948–49, so you are absolutely right.[40] There was a tremendous budget crunch.

Kohn: When you have a squeeze like that, does R&D take second, third, or fourth place? When the squeeze comes, is it especially felt in research and development?

Getting: Let me comment in that regard. In 1950 Congress did not authorize and fund specific research programs. There was a bulk appropriation for Air Force research and there was no Assistant Secretary for R&D in that period. There was no strong centralized DOD budget control. In other words, when the Air Force got the money for R&D, they could do whatever they pleased.

Now in addition to that, there were large sums of money going into foreign aid. This foreign aid went as dollars and it ended up in the Deputy Chief of Staff for Materiel's pocket. If he sent antiquated airplanes as a part of foreign aid, then he got credit for that money and that money could be used for anything.

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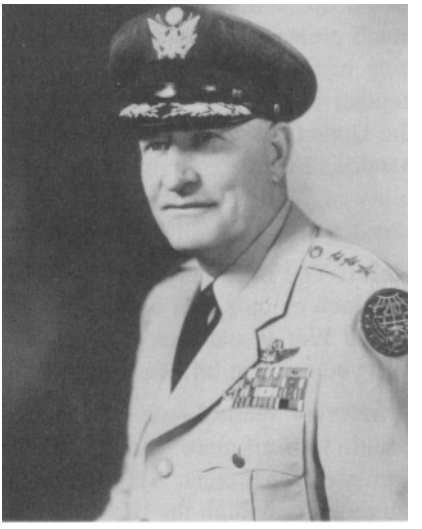
[39] Louis A. Johnson (1891–1966) succeeded James Forrestal as Secretary of Defense in March 1949. During his tenure, Johnson was accused by the Navy of malfeasance in office for canceling the Navy's 65,000-ton aircraft carrier the USS *United States*. At the same time, a paper leaked by a Navy official charged Secretary of the Air Force Stuart Symington with collusion in the procurement of the B–36 bomber. After an investigation by the House Armed Services Committee, these charges were dismissed, but Johnson's position with the armed services and Truman was weakened. Because of his contentious relationship with the State Department at the outbreak of the Korean War, Truman asked for Johnson's resignation in September 1950.

[40] Total military outlays for those fiscal years prior to the Korean War were under $12 billion yearly.

Maj. Gen. K. B. Wolfe



Lt. Gen. Clarence S. Irvine

So in the period between 1948 and 1950, before the government was too well organized to know what was going on, there was a fair amount of money which was flexible. The Air Staff could do a lot of things which today they can't do at all. You could start new programs; you could change programs without a review by Congress, without a review by DOD. I used to describe the Air Force as the last vestige of free enterprise. An officer down at Wright Field could start a program and he would give it a number. No one in the Pentagon could identify that number with any number that was in the programming books of the Assistant for Development. Those numbers were impossible to identify with any numbers over in DCS/M [Deputy Chief of Staff for Materiel]. I think this was good because no one wasted that money. The point was that there was authority and there was initiative and the ability to do things. So you could move forward very rapidly.

You ask, "Did R&D money dry up?" Well, that depended upon whether K. B. Wolfe was speaking to Gordon Saville that day or not as to whether they could transfer some of this foreign aid money to another pocket or use some production money for R&D.

Schriever: Well, between K. B. and Bill Irvine [Lt. Gen. Clarence S.][41] they managed to squirrel away a lot of money that was spent properly. The engine

[41] During the Korean War buildup, General Irvine (1898–1975) returned to Wright-Patterson AFB, as Deputy Commander of Air Materiel Command for Production and Weapon Systems. He helped get new jet bombers and fighters off the production lines and into combat units. After Korea he continued this production specialty in the B–47 and B–52 bomber programs. In May 1955 he was selected to be DCS for Materiel at Headquarters USAF, with rank of lieutenant general.

development, for example, that took place after World War II in the jet engine area was largely funded by Air Force money. Certainly, if we had to defend it on the Hill for specific uses, I'm sure it wouldn't have been made available.

Phillips: Another thing that occurred in that immediate post-World War II period that I observed (as a recipient) was the education of officers. I came back from Europe in 1947, having stayed over there for a while after the war, and had the opportunity to go to the University of Michigan for graduate study in electronics. At that time, the new U.S. Air Force had quite a large program of sending volunteers (officers) to all the main universities in the country; there were hundreds, and that program really paid off for the Air Force. I think it was in that period when they changed the older Army Air Corps training, the institute there at Wright Field, and created the Air Force Institute of Technology. That was a conversion from the older school, which I guess you went to, Ben, before World War II.

Schriever: At that time it was the Air Corps Engineering School. We had six students in my class. From there, four of us went on to graduate school in the university system.

Phillips: The education program and opportunities that were created in the 1940s and carried on for many years were really the foundation on which the Air Force built and expanded its ability to plan and manage its research, development, procurement, production, and acquisition programs.

Schriever: There's no question about that. I'm sure Tom [Marsh] and Sam [Phillips] had dependence upon the Air Force Institute of Technology [AFIT]. I know I was always over there beating on the heads of the personnel people. They wanted to cut back on the number of officers and so forth. We actually were planning ahead for the type of qualifications we needed for AFSC's various jobs. Actually, we initiated action for the institute to take on certain programs in systems management and so forth.

There's always been a very close working relationship between AFIT and the ARDC, then AFSC. I think there should be a history written on the educational system that the Air Corps started after World War I. It had its ups and downs but it's been in existence the whole period. It was only in 1938 and 1939, as we were getting geared up for the war, that they had no classes. I went into the Air Corps Engineering School in 1940 when I was at Wright Field. It was the first class held in three years. It continued even throughout the war, small classes, but they continued them. It was under the sponsorship of that program that the Air Force sent officers to work at MIT and what was then called the Instrumentation Laboratory[42] under Stark Draper [Dr. Charles

[42] The lab was later renamed the Charles Stark Draper Laboratory.

Stark].[43] Bob Duffy [Maj. Robert A.][44] was one of the ones I worked with very closely. Those officers then became the cadre from which the inertial guidance systems of ballistic missiles, and many other applications, derived including some of the space program.

Schriever: You talked about research during World War II. Well, Stark Draper and his work in the inertial guidance, fire control systems, and so forth: that was revolutionary. Let me go back a little bit. I have heard Stark make claims as to what he could do from the standpoint of accuracy with the inertial guidance systems for the last thirty-five years. Some of them sounded completely out of the blue. Well, he has not only been able to accomplish that, but he has done better. Sometimes it has taken a little longer, but he has always done better.

Getting: There was one other item in the post-war period, that of the Ridenour Report—I don't want to give too much emphasis to the SAB because I think the SAB has done a great many things, but they could only do it because they became a part of the Air Force family and were accepted. And they worked as a close team, maintaining a close confidence between the military leadership on the one hand, and the scientists on the other. I think that was very important–unique–as compared to the Army and the Navy.

There was a great insistence on the need for education of technical officers and the establishment of a promotion system within the Air Force so that technical officers could rise to the highest ranks. If Lew Allen [General Lew, Jr.][45] were here, we would have a demonstration that we did have a technical, nonoperating field officer who became Chief of Staff. That was completely unheard of before. I do want to remind you of what Jimmy said earlier. In the 1930s, the Army Air Corps consisted [mainly] of pilots, not technical support people. And these pilots were "gung ho," good American burly boys with scarves around their necks—including you [pointing to General Schriever].

Schriever: Don't depreciate that!

Getting: I'm not trying to depreciate it. The pilots had a very important, critical pioneering role to play. They really did. But the Army Air Corps had little technical depth because, as I said, they depended on Army Ordnance, on the Signal Corps, and on other Army agencies; so the establishment of the type of training that Sam Phillips was talking about was very critical to the health of the service.

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[43] Dr. Draper (1902–1987) was an aeronautical engineer associated with MIT from 1926 until he stopped teaching in 1986. His contributions included heading MIT's aeronautics and astronautics department until 1966 and presiding over the Instrumentation Lab from 1970 until 1973.

[44] Major Duffy was a student at MIT during the 1952–53 school year.

[45] Lew Allen (1925–) was Air Force Chief of Staff from July 1978 to June 1982.

Now there was another thing: facilities. When the Army Air Forces were established, they had Wright and Eglin Fields, period. That was all. They had to make up for it one way or another and one of the things von Kármán did was to spend a lot of time in Europe and grab all the wind tunnel equipment from the [Third] Reich and finally set up the Arnold Engineering [Development] Center in Tullahoma, Tennessee. I think that was a major step in the rapid development of engines after World War II. It gave the Air Force the capability of testing and developing its equipment. To that I think the SAB made major contributions.

Marsh: It is remarkable that [when] I went to Michigan (1952–54), I took a course titled "The Guided Missile Course." Now, it was a graduate program weighted toward different degrees. But the point is, somebody had the foresight, probably as early as 1950 or 1951, to say, "We need a guided missile course," and that was before Bennie.

Phillips: It was way before that. It was back in about 1946 or 1947.

Marsh: That it had that title?

Phillips: Yes. Certainly by 1948 I know it did.

Marsh: That's remarkable, I think, that the Air Force said this is such an important area of endeavor to us that we even need to tailor a course to it.

Getting: Let me give another example of unorthodox procedures that were possible in the 1950–51 period. You may remember that in about 1948, Oppenheimer [Dr. J. Robert],[46] then the Director of the Advisory Committee of the Atomic Energy Commission [AEC], said that the thermonuclear bomb should not be developed. At the same time, Curt LeMay was in the Pentagon pounding his fist at Vandenberg and then later on in 1950 at Gordon Saville that the Air Force needed the thermonuclear bomb.

Well, it just so happened that Army Ordnance had a contract with the University of Chicago which was evaluating the effectiveness of different caliber machine guns in air-to-air combat, particularly for fighters and fighter-bombers. Well, the law said that only the AEC could develop fission bombs, but the law was silent on fusion bombs. So with the help of Roscoe Wilson—"Bim" Wilson [Lt. Gen. Roscoe C.][47] who was then the Atomic Energy Commission Air Force liaison officer—and with the advice of the General Counsel that "fusion was not spelled the same way as fission." We changed Project

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[46] Dr. Oppenheimer (1904–1967), who was instrumental in the development of the atomic bomb, served as chairman of the general advisory committee of the Atomic Energy Commission from December 1946 to July 1952.

[47] In June 1943 Colonel Wilson (1905–1986) became Army Air Forces Project Officer to support the Manhattan Project and was one of the first officers involved in the development of the atom bomb. Wilson chose the site for the bomb's first test, near Alamogordo, New Mexico.

Chore[48] and got Dr. Edward Teller[49] to work on the hydrogen bomb designs at the University of Chicago under an Air Force contract. That was never reviewed by any committee in the Congress; it was never reviewed by anybody. I'm again pointing to the flexibility, because as we continue our discussions and we listen to the frustrations of Tom Marsh and Sam Phillips later, you'll see that things changed. I regret very much that this flexibility has been removed, the ability to react quickly to changing circumstances.

Schriever: Let me give another example of where the SAB came in and made a tremendous contribution. In 1953 we had an SAB meeting at Patrick AFB [Florida] in the spring. It was right after the first thermonuclear weapon test—Project Castle—and of course that was a huge wet device. It weighed about 50,000 pounds. I had heard somewhere along the line that Edward Teller was saying that you could make a dry thermonuclear weapon and that it could be much lighter. At this SAB meeting, both Edward Teller and [Dr.] John von Neumann[50] made presentations and both indicated that you could actually develop a dry thermonuclear weapon that would have a megaton yield and would not weigh more than 1,500 pounds. They indicated that would be possible, if the development was undertaken by 1960.

Well, I was running the Development Planning Office at that point, and I had several meetings with Bradbury [Dr. Norris E.][51] in Los Alamos [New Mexico] trying to get a projection on what was possible in nuclear weapons, in terms of weight and yield, because it was important for our total planning for weapon systems which take five, seven, or eight years to get in the inventory (much longer today). But I never got anything out of Bradbury except what was on the production line. I went to visit von Neumann at Princeton [New Jersey] the next week and got him to say he would chair an SAB panel that would give legitimacy to what he and Teller were saying. We set up that panel in the spring right after that meeting. In June of 1953 they put out a formal report. Incidentally, Bradbury was on the committee, York [Dr. Herbert],[52] Teller, and von Neumann was chairman—about ten or twelve people

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[48] Project Chore was an Army Ordnance effort to evaluate the effectiveness of air-to-air combat guns. Dr. Getting's office redirected the work into an Air Force contract on nuclear weapons research.

[49] Dr. Teller (1908–), an internationally known physicist, served on the World War II team that developed the atomic bomb and became an advocate of developing fusion weapons. From 1958 to 1960 he directed the Lawrence Livermore Radiation Lab at the University of California.

[50] In October 1953, Secretary of Defense Wilson named Dr. von Neumann (1903–1957) chairman of a special committee of scientists appointed to reexamine U.S. development of an effective ballistic missiles program.

[51] Dr. Bradbury (1909–), a physicist, directed the Los Alamos Scientific Laboratory in New Mexico from October 1945 to October 1970.

[52] Dr. York (1921–) served as Director of Defense Research and Engineering from December 1958 to April 1961.

on it, the best brains in the country. They came out with, "Yes, it could be done by 1960; 1,500 pounds; one megaton," We were off and running on the ICBM[53] Program!

We had another von Neumann committee which Trevor Gardner[54] set up, to look at the overall strategic missile programs that were going on. We had the Snark and the Navaho; the Atlas[55] was sort of in the planning stage. We didn't have any money for the Atlas, but there was planning. That von Neumann report came out in February 1954 and recommended that we undertake the ICBM program. That shows you what we could do in those days, and how important the Scientific Advisory Board was in providing the kind of credibility to making forecasts of technology. That led to the initiation of the ICBM program and all of the space things that came out of the ICBM program.

Kohn: General Schriever, what did you do to break through the system to create the ICBM? You all have talked a little bit about the coming bureaucratization of research and development.

Phillips: Before General Schriever and Ivan comment from a higher level, let me tell you a story or two about the working level. When I finished Michigan in January 1950, I was assigned to Wright Field, which is where I wanted to go. At that time the Air Materiel Command still existed. Within the Air Materiel Command there was an Engineering Division. The two powers were the Procurement and Production Division, and the Engineering Division.

In that period I was involved in a number of developments, including

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[53] In the early 1950s the Air Force, Army and Navy all were developing ballistic missiles. Terminology identifying these missiles centered on range; ICBMs were intercontinental ballistic missiles with ranges in excess of 5,000 miles. The IRBMs were intermediate-range ballistic missiles with a range of approximately 1,500 miles. The Air Force, because of its strategic mission, was assigned development of ICBMs. The Army and the Navy had joint responsibility for development of IRBMs until 1956, when Secretary of Defense Charles E. Wilson directed in a policy memorandum that the Air Force would research, develop, deploy, and operate all land-based ICBMs and IRBMs. The Army was restricted to deploying and operating ballistic missiles to a range of 200 miles, while the Navy was assigned development and deployment of all ship-based IRBMs.

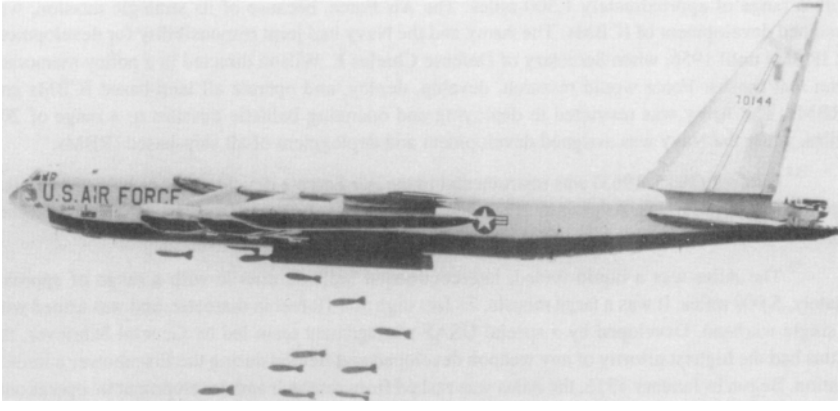
[54] Gardner (1915–1963) was instrumental in the Air Force's development of ballistic missiles and aerospace programs, helping to create the Western Development Division which was responsible for the development of the Atlas, Titan, and Thor.

[55] The Atlas was a liquid-fueled, intercontinental ballistic missile with a range of approximately, 5,000 miles. It was a large missile, 75 feet high and 10 feet in diameter, and was armed with a single warhead. Developed by a special USAF management team led by General Schriever, the Atlas had the highest priority of any weapon developed and fielded during the Eisenhower administration. Begun in January 1955, the Atlas was rushed from research and development to operational status in September 1959. For a few years, Atlas missiles were the bulwark of the nation's ICBM deterrent force; then in the 1960s, SAC's missile force gained the more advanced Minuteman and Titan II missiles. By June 1965 all of the Atlases had been removed from the active force, though it remained a major space launch vehicle.

what today would be called "the program director" on the B–52 development. In that period, there was, in effect, a handover: the research and development people in the Engineering Division would reach a certain stage of development, at which point a system, an airplane, or something was ready to go into production. It was then handed over to the Procurement Division. The engineering people then changed, when tolerated, into a supporting role.

It was in that same period, in 1950–51, when the [Air] Research and Development Command was formed; the Engineering Division was the cadre around which that command was organized. As General Schriever said earlier, although the organization of ARDC gave a lot more stature to the engineering people, in some ways it made the process even more complicated because the handover wasn't between two divisions of AMC. It was between two commands of the Air Force, so that a system like the B–52 in development was actually handed over in the formal process from ARDC to AMC.

The device that was developed in that period to make that transfer work was joint project offices. Some of us who were involved took various steps on our own initiative. For example, in the B–52 in the latter stages of its development and transition to production, I was the ARDC project officer and Ed O'Connor [Lt. Gen. Edmund F.] was the AMC project officer. We agreed together that we would put our offices in the same room and our staffs in the same area. So we really worked as a full joint project office. I think that made the system work; we were able then to work effectively with Boeing as the prime contractor and with a number of other contractors to guide for the Air Force the combination of development and production. There was a major problem in that period, as I look back.



The procurement process for the Boeing B–52 Stratofortress was a test case for cooperation between AMC and ARDC.

Getting: Let me comment. When the Ridenour Report came out and Jimmy Doolittle was selling it to Vandenberg, he had to fight the Air Materiel Command structure. A part of the solution to that was a compromise that while ARDC would be set up—and I'm sure Bennie is going to address this later because he was the guy who then carried on subsequent steps—it was specifically denied the warrants to do the legal procurement. As a result, AMC kept going as the procurement partner.

I want to mention two other innovations in the R&D field that I think the Air Force should get credit for. One was the establishment of the Chief Scientist's Office. That was done, if my memory serves me correctly, by Gordon Saville. The Chief Scientist was to be a civilian scientist without any specific responsibility, but reporting directly to the Chief of Staff. The first Chief Scientist officially was Louie Ridenour [Louis N., Jr.],[56] who was a great man. He has died and we can speak of him as kindly as we want to. He helped very much, with Bennie and me, in starting, for example, things like the Lincoln Lab. I wanted to bring that up because that is another innovation the Air Force undertook. Now the Chief Scientist has continued year after year after year.

David Griggs[57] was Chief Scientist number two. He was the one who was the spokesman for the Air Force in getting the thermonuclear bomb really going and in the establishment of Livermore Laboratory as the second laboratory to give Bradbury some competition, because Bradbury was hanging back. He was sort of the disciple of Oppenheimer. The establishment of the second laboratory at Livermore has been critical to the Air Force both in development of thermonuclear bombs and the competition with Los Alamos in the small tactical nuclear weapons that came later. Each Chief Scientist sort of picked up some cross of his own; it depends on the Chief Scientist and the Chief of the Air Force as to what that Chief Scientist does. Almost without exception they have been able to act as an extra wheel that would fill in little cracks of the strict organization I mentioned earlier that the Air Force didn't provide.

The other thing the Air Force has been wise at, and I think Bennie will come to this later also, was to seek rather freewheeling civilian scientific organizations to help the Air Force in its R&D responsibilities. I mentioned Project Lincoln, which became Lincoln Laboratory in 1950 as an example of that. Again, the problem was that the rigid structure of any large organization in the military (the largest of all organizations) prevents, as it gets older and matures, much freewheeling. The budget cycle got to be longer and longer so that one had to predict what one was going to do in R&D three years hence.

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[56] Dr. Ridenour (1911–1959) served as Chief Scientist from September 1950 until August 1951.

[57] Dr. Griggs (1911–1974) was Chief Scientist from September 1951 to June 1952. Prior to his appointment, he was a professor of geophysics at University of California, Los Angeles.

But three years later you wish you hadn't said you were going to do that, because by that time, time has gone on and you've got some brighter ideas and you wish you could do something else. But you get frozen into this cycle, and into the system, and it inhibits progress. The other thing is that some of the inhibiting of the government's structure and the civil service did hamper in attracting some of the better scientists and engineers. At least the Air Force stepped up to this problem as in the case of the air defense problem by setting up Lincoln Lab, which came out of a work but not a recommendation of the Asset Committee of the SAB.

The Lincoln Laboratory has demonstrated for over thirty-five years that it can meet new challenges as they come along, develop new technologies, and put the Air Force in leadership in many areas. That's why I think in a meeting like this we should recognize that the Air Force's willingness to invest in outside help, to try new procedures and new methods of solving problems, has been a great tribute to it and I think a great boon.

Schriever: Let me just add to what you said. I was at the Air [Force] Council meeting when the Livermore Lab was discussed in detail. The Livermore Lab was really established at the initiative of the Air Force. There are just no two ways about it. Dave Griggs was really the guy who was carrying the ball on it. I think it has been very healthy for the country to have these two laboratories, not just because of the thermonuclear bomb but everything else they have done. They have done some tremendous work. They are friendly competitors now. I don't see any friction between the two labs. There was quite a bit of friction in the early days.

Kohn: Are you gentlemen saying that in the early 1950s, even as ARDC was being developed and created as a command, there were still procedures and bureaucracies that had to be circumvented or overridden? Or, am I misrepresenting this?

Getting: You are saying it almost correctly, but that is not quite accurate. You must always put yourself in the temper of the times. In 1950 the Russians demonstrated long-range bombers. They had already demonstrated a nuclear weapon. This country went from a sense of isolation and complacency—we never could be attacked—to a sudden feeling that we could be bombed out of existence by Soviet bombers coming over with nuclear weapons. Today we all know that, but in 1948 that was not even conceivable! The Russians were stupid! They could never make an A-bomb and they could never make bombers like the B–29.

There was no emphasis on R&D; there was no money. Therefore, the work at the Rome Air Development Center, which had been barely set up in a warehouse with a bunch of people who were snowbound all winter. No progress had been made.

In 1948 there was no night fighter in the inventory of the Air Force—no night fighter, not one. There was no AI [airborne intercept] equipment, no AGL [airborne gun laying]. And our mutual friend, Gordon Saville, who operated out of the Air Defense Command in Long Island, really set up the Hughes Aircraft Company by giving them a sole-source contract to copy the General Electric AGL II of World War II. There was no research and development; just produce it and put it in the trainer so we had some capability. When you looked at the air defense network at that time, you found that the Rome Air Development Center (which just found out where the bathroom was, much less how to run a new development) had just moved people in from Watson Laboratory and hadn't made any progress whatsoever on radar and MTI [moving target indicator] and low-flying airplanes.

Faced with these difficulties and in that atmosphere, in order to move ahead fast, we—Bennie Schriever, Ridenour, Gordon Saville and I—decided we had to go outside of this system and try to organize what almost approached a wartime effort to catch up. The only way we saw to do that was to take the ADSEC[58] [Air Defense Systems Engineering Committee] group[59]—George Valley [George Edward, Jr.], Al Donovan [Allen F.], Stark Draper, Guy Stever [H. Guyford] and a few other well-known names in the Air Force, and convert it into a full-time, hard-working, effort of the Radiation Laboratory type. That's why we picked MIT. Against the opposition of many of the faculty, MIT took on that Lincoln project. But you must recognize the urgency of the time.

Schriever: I think when you look at later periods, you will find that in doing the overall job of research, development, test, and acquisition the Air Force has always gone outside for assistance and has found it. Tom [General Marsh] has done it, Sam [General Phillips] has done it, I did it, and the conditions—as Ivan points out—dictate to some extent the degree of support that you get for what you try to do.

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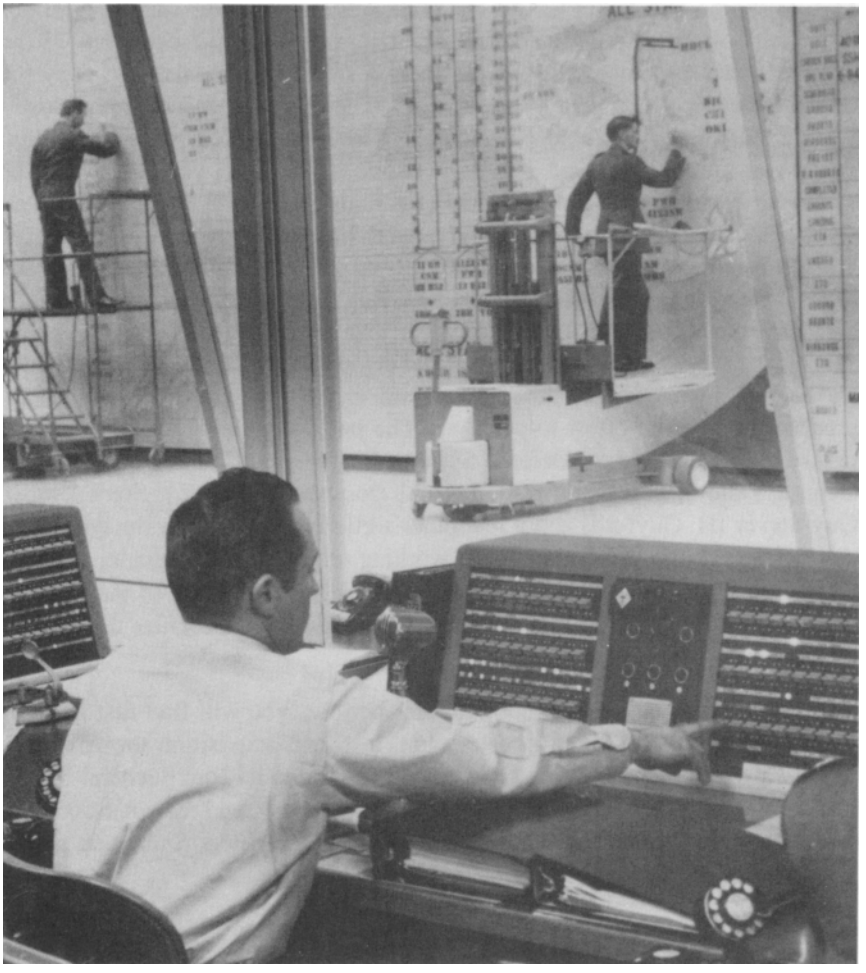
[58] ADSEC, established by the USAF Scientific Advisory Board, was chaired by Professor Valley.

[59] Valley (1913–)was a physicist, a member of the Scientific Advisory Board from 1946 to 1955, and the Air Force Chief Scientist from September 1957 to October 1958. Since 1946 he was a professor at the Massachusetts Institute of Technology. He also assisted in the founding of the Lincoln Lab in 1949.

Donovan (1914–) was head of the Aero Mechanics Lab at Cornell University from 1946 to 1955. He was the director of Aerospace R&D staff at Space Technology Labs from 1957 to 1958 and vice president from 1958 to 1960. Donovan became senior vice president at Aerospace Corp in 1960 and served in that position until 1964.

Stever (1916–) was Air Force Chief Scientist from February 1955 to July 1956. He also became a member of the Air Force Scientific Advisory Board in 1946, serving as its chairman from January 1962 until April 1968.



Emergency war plans would have been directed from Strategic Air Command's war room, located forty-five feet below Earth's surface, at Offutt AFB, Nebraska.

The 1950s

Kohn: What were the major procedural innovations in the ballistic missile program? How did the Air Force press forward with that research and development so quickly and to what extent would that become the model for research and development projects generally? What does the ballistic missile program have to tell us today about the process of R&D?

Schriever: There are a number of factors and the program didn't all fall into place at the same time. To start with, the ballistic missile program was initially given the highest priority of any program in the Defense Department, once the recommendations of the von Neumann Committee were approved through the Pentagon. Ballistic missiles received number one priority. That's very important. This and other conditions permitted us to create a unique management approach. Second, we had in the Pentagon at the time an Assistant Secretary for R&D—he wasn't quite called that at that time but he became that—named Trevor Gardner. He was highly motivated and was involved in the evolving decision within the Pentagon that we should proceed with an ICBM program. So Gardner was in a position to push things, and he knew how to push things. Those were ingredients that were absolutely essential.

A third factor was organizational, Tommy Power [General Thomas S.][60] was in command of ARDC, and when I was given the job of running the ICBM program, I was made assistant to the commander for ballistic missiles. That gave me authority over all elements of the ARDC that I might need. The very fact that I was made assistant to the commander for ballistic missiles, meant that I never had any problems; I didn't have to coerce anybody to provide support. I got very, very good cooperation within ARDC. Then we developed the procedures. I might say that it took us about six months to go through this exercise. After the decision was made to proceed with the ICBM, we developed a set of procedures within ARDC on how we would manage the program, the authority I had, and so forth. Those procedures were, in fact, written up under General McCormack [Maj. Gen. James, Jr.],[61] and John Hudson

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[60] General Power (1905–1970) was commander of Air Research and Development Command from April 1954 to July 1957.

[61] In February 1952 General McCormack became Director of Nuclear Applications at the Air Research and Development Command in Baltimore, Maryland. He was named Vice Commander of ARDC in May 1952, Deputy Commander in December 1952, and Vice Commander again in July 1953.

Above left: **Maj. Gen. William F. "Bozo" McKee (shown as the Air Force's Assistant Vice Chief of Staff).** ***Above right:*** **Maj. Gen. James M. McCormack, ARDC's Vice Commander.** ***Left:*** **General Thomas Power at SAC Headquarters, Offutt AFB, Nebraska, in 1961.** ***Below left:*** **On March 1, 1955, Trevor Gardner (left) was sworn in as Assistant Secretary of the Air Force for R&D by Secretary Harold E. Talbott.**

[Lt. Gen. John B.] was really the guy who did most of the detail. It was checked with me as it was proceeding but Jim McCormack, who was Vice Commander of ARDC at the time, was very helpful in creating the ARDC procedures.

Next was how do we deal with AMC and here I ran into a hell of a lot of trouble. I wanted to have complete authority over procurement, and I wanted to have complete authority over the money. I wanted that assigned to ARDC. Well, General Rawlings [Edwin W.][62] demurred on that one. Also, I didn't get the support from the Air Staff. I still have a picture taken at AMC Headquarters with Ed Rawlings and all of the generals there—Tommy Power, Bill Irvine, and several others. I'm standing there, the only brigadier general in the group, and I'm looking up like this—my eyes are up at the ceiling. In other words, I had lost my battle. But I had won enough anyway, I thought, to continue.

What happened was that they did give me authority for the total program. They would set up an office out there on the West Coast manned by AMC people but they would be directly under my control, and I would write their efficiency reports. I would have control of the money; the money would flow directly to what was then WDD [Western Development Division]. It turned out that I had some difficulty in making that stick, but it did. After fighting with AMC a bit, I controlled the money.

So I controlled the people and I controlled the money, and I also had cooperative people from AMC. So it worked fine. They were not in my command, so to speak; they were a separate element under my control. We did have some problems, but I had direct access to General Rawlings and "Bozo" McKee [General William F.],[63] who was his vice commander. All I had to do was pick up the phone and say, "Straighten this out for me, please," and they did it just like that. There wasn't any paperwork involved. It was done verbally. As a matter of fact, I don't even remember ever writing a letter to General Rawlings or General McKee saying, "I'm having a problem with so and so." It was all by telephone. So that covers the ARDC part and the AMC relationship.

One other aspect which I should have mentioned in connection with the first two elements was the von Neumann Committee, which continued to be the advisory committee to the ICBM program. These people provided all the credibility for the program in terms of dealing with the outside world. They had credibility in the Pentagon, with the Secretary of Defense, the Secretary

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[62] In July 1951 General Rawlings (1904–) became head of Air Materiel Command at Wright-Patterson AFB, Ohio. He commanded AMC throughout the period of the development of ballistic missiles and space systems which required new techniques in Air Force supply, distribution, and support.

[63] General McKee (1906–1987) was Vice Commander of Air Materiel Command in 1948.

of the Air Force, and the scientific community. I don't think the program could have really been accomplished without the von Neumann Committee being part of the total structure.

Let me go next to dealing with Washington. The Pentagon, of course, is organized on a functional basis, with assistant secretaries for different functions and the deputy chiefs of staff for different functions. Initially, of course, they protected their "turf." I would have to go to the Assistant Secretary for Materiel on anything having to do with industrial facilitization; I'd have to go to somebody else for any facilities having to do with the Corps of Engineers—in other words, test facilities, R&D facilities. Then I had the Deputy for Materiel, Deputy for R&D, the General Counsel, and so on. After about six months of this, I had a chart drawn up showing all the points I had to go to where people could say "no," until I finally got to where somebody could say "yes." I had about six charts. I went in and briefed "Trev" [Trevor] Gardner on this. He said, "Let's go down and see Quarles [Donald A.]."[64] Quarles was the Assistant Secretary for R&D. Quarles, who was about to leave the office, was standing up behind his desk when Trev marched in there. (Of course I knew Don Quarles well, too.) Trev said, "Don, you've got to listen to this." He was about to leave the office. We pulled a chair up. In those days we didn't have viewgraphs. We still had big, heavy charts. I sat them up on the chair; I went through it in about fifteen minutes, and Quarles said, "We've got to straighten this out." (Incidentally, he had been the one who approved the creation of the Ramo-Wooldridge organization to direct the technical systems engineering, later in September of 1954. We had gone through all kinds of iterations as to how we would manage it out there on the West Coast.)

About six months later, the Gillette Committee was created. Trevor Gardner and I picked all the people for the committee; the procedures were approved by the President himself. Those procedures established an office in the Pentagon headed by Sam Brentnall [Maj. Gen. Samuel R.],[65] where all of the ballistic missile "stuff" was focused. I didn't have to go to any other staff office, just to Brentnall's office. Nobody on the Air Staff could say "no." Nobody in the assistant secretary slots could say "no." We came in with our programs to the Ballistic Missile Committee. I would bring in my program directors and we would usually have about a two-day session. (We would send in our program documentation roughly a month ahead of time). If anybody had anything to say, they had to say it at the time that we made the briefings. Sometimes we communicated informally, of course. And we also made changes on an infor-

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[64] In September 1953 Quarles (1894–1959) became Assistant Secretary of Defense for Research and Development. He was served in this capacity until January 1954.

[65] General Brentnall (1903–1965) was Assistant Chief of Staff for Guided Missiles from April 1954 to September 1956.

mal basis. This was done through an agreement, though, not somebody saying, "You can't do this or that."

Once the program was approved through the Air Force Ballistic Missile Committee, it went the next day to the Office of the Secretary of Defense's [OSD's] Ballistic Missile Committee, which was chaired by the Secretary himself. We would usually go through that in half a day. Once that program was approved, that was it as far as the Pentagon was concerned. The program documentation became really a meaningful program documentation because that was our program.

As far as the Congress was concerned (we didn't have the problem with the Congress that we have today), they were all for it. I coordinated with the programs people on the Air Staff and with the Legislative Liaison people. In presenting our program to the Congress, I would always give the basic presentations and be the key witness with the Air Staff people there. We would have gone through all the documentation. We never had any real problems with the Congress. Not that we got a blank check every time around, or anything like that, but we had very strong support from the Congress. In other words, a sense of crisis did exist at the time that we needed it to really move forward with the ICBM program.

In a nutshell, that is the way in which we structured it from a management standpoint: how we handled it within ARDC, the relationship with AMC, the von Neumann Committee, the Ballistic Missile Committees at the Air Force level and DOD level, and then the relationship with Congress. Once the money was appropriated, I had control of those monies. It was identified for certain things, but I had a great deal of flexibility in moving money around. For example, I had enough flexibility to start a feasibility program for solid propellant. In the summer of 1955 the von Kármán Committee said that a solid propellant ICBM was possible; that suggested a feasibility program. I didn't have to go to the Pentagon for that because I had the $20 million to go ahead with it. The Minuteman[66] program and the Polaris programs got started subsequently because, working with industry we established that it was entirely feasible to develop a long-range ballistic missile with solid propellants. That allowed us to leapfrog Soviet missile development.

The system stayed in effect until von Neumann died and Clark [B.] Millikan[67] took over as chairman of that committee. The policies, procedures, and

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[66] Minuteman missiles have been the United States' principal land-based, intercontinental ballistic missiles from the Kennedy administration (1961–1963) to the present. By 1964, the Air Force had 700 Minuteman I missiles assigned to the Strategic Air Command. During the next ten years, the total number of operational Minuteman missiles, positioned in hardened, underground silos and continually ready to be launched, grew to 1,000. However, by 1969, newer models, the Minuteman II and III, had replaced the first generation of missiles.

[67] Dr. Millikan (1903–1966) was an aeronautics professor at Caltech from 1929 until 1948. He served as director of the Guggenheim Aeronautics Laboratory and was also a member of the Air Force Scientific Advisory Board from 1952 until 1966.

the priorities continued on the program through the Eisenhower years. It wasn't until the early 1960s, about 1962 or 1963, that we began to get unnecessary help from the "third floor"[68] of the Pentagon. They tinkered around with the procedures. That was really John [H.] Rubel's[69] doing, helped and aided by Gene Fubini [Eugene G.][70] later on. By the time I had retired, in 1966, they had completely dismantled those procedures and that's when the micromanagement approach to systems acquisition really took hold. I would say that the degree of micromanagement has increased exponentially. Now most programs are managed by OSD staffers and the Congress. But that is another story. We will let Tom Marsh cover that one.

Phillips: There is one other element in that early organization you might want to comment on: the relations with SAC and the way that was handled.

Schriever: Yes, thank you, Sam. We realized that we were plowing new ground insofar as weapon systems were concerned. We had no experience in the logistics, the training, or the operational side of long range ballistic missiles. We decided that we needed to have representation from the major commands of the Air Force, with SAC being number one on the priority list. (We already had the AMC people there so that logistics and contracting services would be natural undertakings for that AMC office.)

SAC sent Dick Henry [Lt. Gen. Richard C.],[71] who later became the commander there. He was only a captain at the time, which indicated that SAC didn't have really a great deal of enthusiasm for the ICBM. But I will say that SAC was very supportive. I think General LeMay had some concerns about the liquid-propelled ICBMs. Let me say that, secretly, I did too—particularly with the Atlas which we had to start from an empty condition and be able to launch within twelve minutes. I thought it was impossible but we did it in eight minutes! SAC supported the program. Of course Tommy Power,[72] when he went to SAC, was a strong supporter of the ICBM program as well as the follow-on space systems that we were beginning under the old 117L[73] Program.

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[68] This refers to the Office of the Secretary of Defense, located on the third floor of the Pentagon.

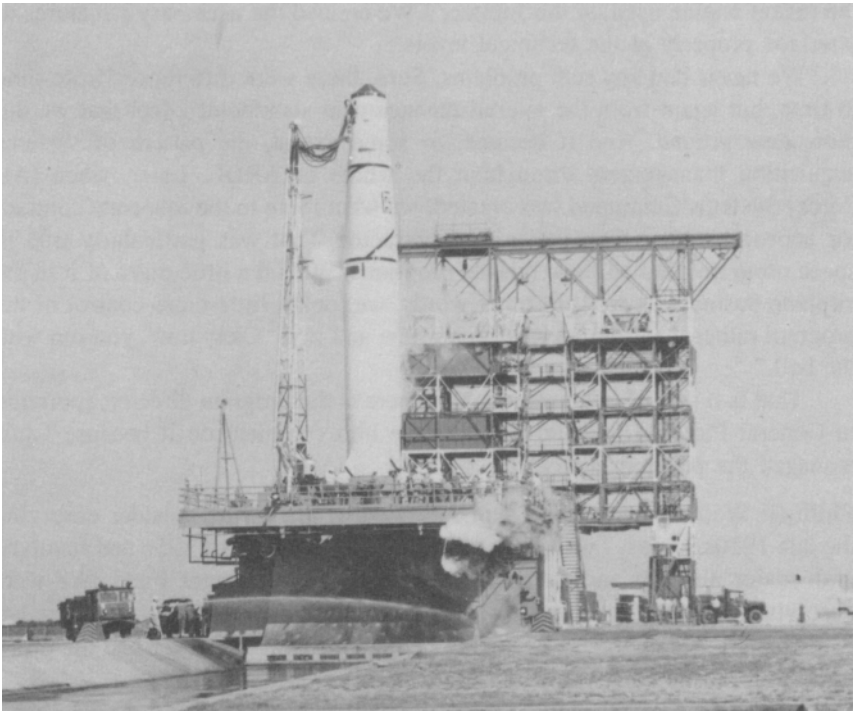
[69] Rubel (1920–) was Assistant Secretary of Defense (Deputy Director Defense Research and Engineering) from May 1961 to June 1963.

[70] Dr. Fubini (1913–) succeeded John Rubel as Assistant Secretary of Defense (Deputy Director, Defense Research and Engineering) and served from July 1963 to July 1965.

[71] Captain Henry (1925–) was SAC's representative in the Ballistic Missile Division.

[72] General Power succeeded General LeMay as Commander-in-Chief of the Strategic Air Command in July 1957, serving until November 1964.

[73] The 117L Program was the designation for the Air Force's satellite programs.



A Thor IRBM readied for static test firing at Cape Canaveral, Florida in June 1958.

I think we did plow new ground in the way in which we managed and the way in which we planned from the beginning on a concurrency basis, not only with the development and test aspect, but with how we would get it into the inventory. The charter I had was to get an operational capability at the earliest possible date, which meant not just to develop something that would work, but also to get it into the field. So we had to take all those things into consideration right from the very beginning. That's how we got the SAC representation and how we got the [Air] Training Command into the act very early in the game as well.

Incidentally, we had some Navy people in the organization to begin with, and we worked very closely with the Army later on when the IRBM [intermediate range ballistic missile] came along. That was pretty early in the game because the rocket engine that was on the Atlas and on the Thor[74] was also

[74] The Thor was developed in the mid-1950s as an intermediate range ballistic missile. Thor missiles could deliver a nuclear warhead approximately 1,900 miles. Between 1959 and 1965, the British Royal Air Force had three squadrons of the American-developed Thor missiles, with each RAF squadron possessing twenty missiles. By the end of 1963, the Thors had been withdrawn from Europe.

the rocket engine used on the Jupiter.[75] We created the necessary structures to interface properly at the technical levels.

We never had any real problems. Sure, there were differences from time to time, but again from the overall management standpoint I feel that we did plow new ground. And it became, to some extent, the pattern of systems acquisition management throughout the whole of ARDC. Later, when [Air Force] Systems Command was created, we went more to the associate contractor approach rather than the prime contractor. That was particularly true in space programs and ballistic missile programs. We did a little more of it in the airplane business as well. In other words, we took a little more control of the program rather than to give it all to a prime and say, "Okay now, you run with the ball."

That is it sort of in a nutshell. Now here is the program director; [pointing to General Phillips] I would like to have him comment on it because I just managed the program directors.

Phillips: Well, I have some comments, first of all, as the outsider observing the late 1950s period. I was still at Wright Field up through 1956 and involved with major airplane and armament developments at Wright Field. We were observing very closely what was going on out on the West Coast for a number of reasons. For one, they were taking people. General Schriever had the priority to pull people from wherever he wanted.

It was apparent that there was a major revolution of process going on. One of the most visible signs to us from a distance was the source selection process. In other words, a team was created involving not only the program requirement side on the Air Force part, and planning and direction, but the technical support which was then provided by the Ramo-Wooldridge Corporation which also encompassed the procurement support. In other words, the contracting officers were part of the team although they were part of AMC. For all practical purposes, it was an integrated operation. They were able to come up with some very effective procedures to develop specifications and contract documentation, run competitions, make selections, and award contracts very rapidly. That was one of the things I think was a very significant revolution in the process that enabled very rapid action.

I became directly involved in 1959, after a tour in SAC, when I was assigned to General Schriever's organization, the Ballistic Missile Division, in Inglewood, California, as the Minuteman program director. By then the Minuteman had been underway for one year. The program had been defined and

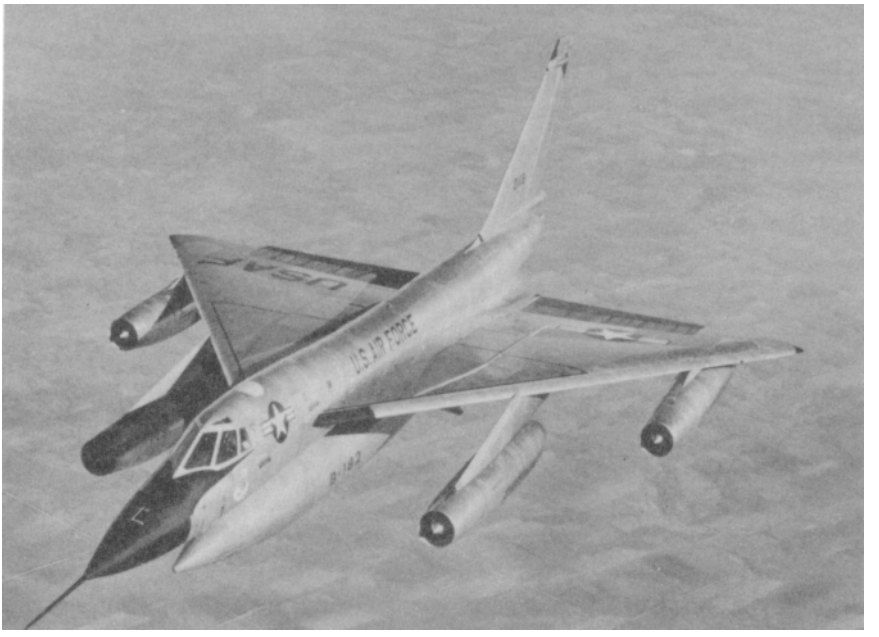
[75] The Jupiter was another American-developed intermediate range, liquid-fueled ballistic missile with a range of approximately 1,900 miles. The missile was deployed in single squadrons, in Italy and Turkey. As of 1961, the U.S. Air Force jointly operated these thirty-missile squadrons with the air forces of the host nations. By the end of 1963, the Jupiters had been withdrawn from Europe.

(Left to right) Col. Sam Phillips, director of the Minuteman Program Office; Maj. Gen. O. J. Ritland, Commander of ARDC's Ballistic Missile Division, executive managers of the Minuteman program; and General Schriever, Commander of ARDC, inspect the communications panel in a Minuteman launch control car.

had been put on contract with the associate contractors in 1958, so it was one year underway when I joined it as a colonel in 1959.

The organization that we put together after I came into the picture had strong individuals from each of the Air Force command organizations that General Schriever has mentioned. For example, into the early 1960s I used Jim Foster, who was from the Air Materiel Command. He had the procurement warrant and the contracting officers worked directly for him. I set him up essentially as the deputy for the procurement and logistics support functions that were a part of the Air Materiel Command responsibility. We had an element in the program office of people from the [Air] Training Command. Their responsibility was to plan for the equipment, the courses, and other material that would be required to train people. We had people from SAC who were right in the program office. Although we obviously operated in what I think was a very professional and legal way, we weren't really bound by the traditional regulations as to how things were to be done. We had the latitude, supported by the structure that General Schriever had established, to proceed in a businesslike way to get the job done.

My own view is that in that period of the late 1950s and early 1960s, the process of planning and executing development and acquisition programs was really revolutionized. The processes that we established involved very thorough planning, this being at the program office level. There was the development of a very detailed program plan of schedules, logistics, training, and the whole aspect. As I recall, there were something like seventeen sections that had to be prepared to cover all the aspects of the total concurrent program of technical competence in depth. This was provided to us not only by some very



A delta-wing Convair B–58 Hustler with a ventral weapons pod. The Hustler was capable of speeds above Mach 2.

capable Air Force officers in the program team, but from what by then was called Space Technology Laboratories of Ramo-Wooldridge Corporation as the system engineering and technical direction contractor. As I recall, we had a stable of seven associate contractors: Boeing for integration and tests, engine contractors, guidance, and so on.

The point to be emphasized, though, is that we were able to avoid much of the red tape, process procedures that took up so much time and energy of people, and instead to devote our time and energy to planning and executing the program. That really was a revolution of the process. It was essential to accomplish the job that we had, which was to get that Minuteman system operational, under SAC direction. It turned out to be in a period of four years. The Minuteman went on contract in 1958. We turned the first flight of missiles over to SAC in October of 1962 (four years) and it was well done.

Kohn: Was the revolutionary character of what you did with the ballistic missiles related directly to the creation of Systems Command in 1961? Did that grow out of the process at all, or was that separate?

Getting: Let me comment, if I may, because Bennie brought up some very critical points and Sam enlarged on them. The Air Force has matured in the management of research and development, but it's not an easy process because the Air Force is a big organization. I want to take the B–58 as an example,

which is one of Bennie's favorite airplanes. I think he was the father or the mother, or both, of the B–58. That was an example, prior to the establishment of the associate contractor and assistant engineering concept, where Wright Field awarded the prime contract to Convair. Convair then subcontracted the bomb-nav system to Sperry. Sperry then subcontracted it to Raytheon for the bombing radar and for the navigation radar, the thing that looked down and got the doppler.

I happened to be Vice President of Raytheon at the time so I was now looking from the bottom of this pit instead of from the top. We were forbidden at Raytheon to talk to anybody but Sperry. Sperry was forbidden to talk to anybody but Convair, because Convair didn't want to let anybody in the Air Force find out what the truth was. At Convair they made all the tradeoffs to their advantage. They pushed all the problems and put all the blame down to the subs [subcontractors].

The Air Force had little visibility into what was going on in the B–58. I will give you two examples: the specs were so tight on that airplane by Convair, because they wanted to have the high rate of climb and keep the weight down, that all the chassis were made of magnesium milled down to an accuracy of 5/1000ths of an inch. It cost about $5,000 apiece just for the chassis. All the cooling came from the pressurization of the airplane. Unfortunately, when the pilot got into the airplane down in Texas and he opened up the canopy, there was no cooling air in any of the electronics so the resistors fried, swelled up, and got bubbles on them. Capacitors got bigger and bigger until they burst. There was nothing we could do at Raytheon. We couldn't tell Sperry to tell Convair to tell the Air Force, "Don't operate the equipment with the canopy open." It was silly, absolutely asinine, the whole thing, the whole management!

Another example: there was a separate organization for facilities. If we wanted to change a mold for the radome, which was about one-third of the aerodynamic part of the bottom of the airplane, we had to go to Sperry and had to combine their facilities [requirements] for that year and go to Convair and they had to combine their facilities and then go to the Air Force and the Air Force had to get their facility people in. A year later after the change was made and after radomes had kept coming out, we would get approval to go on with it and change the die. Now I'm not kidding! These are facts! This is management by rule, and through a long chain.

Now one of the things that Bennie did was to get the associate contractor so he had immediate access to each of the major suppliers, and he was able to have full visibility and integrate.

Schriever: I guess I should have covered the Ramo-Wooldridge thing a little more in detail. One of the biggest issues was whether or not we went prime contract or associate contract. The von Neumann Committee felt that there was not enough knowledge in any single company to undertake the program. They

also felt that the Air Force did not have the resources, manpower-wise or quality-wise, to launch a major program of this type (plowing new ground and with no experience) without some unique management organization. That led to the selection of Ramo-Wooldridge then as the SE/TD [systems engineering and technical direction] contractor.

Then there was a discussion as to whether they would be just technical staff, or would they be in the line? It was definitely decided that they would be in the line and have a systems engineering and technical direction responsibility, and that it would be exercised over the associate contractors. Because of co-location and working together, as Sam pointed out, it was really a team effort because Bennett, for example, was your deputy for technology. We had military personnel who were highly qualified technically throughout the whole organization.

Let me reiterate that two things really are absolutely essential in a major program of this type: that you have control of your people, and you have control of the money. Probably even more important is that you have highly qualified people and certainly—just as Sam points out—I was given priority. I wasn't quite able to "steal" everybody, but Sam Phillips was under orders to go to the Industrial War College,[76] and he ended up running the Minuteman program.

Another example: I was on an airplane going from Albuquerque to Los Angeles and Terry Terhune [Lt. Gen. Charles H., Jr.][77] sat down. I said, "Terry, how are you?" He was stationed in Albuquerque, and I had gotten to know him when we were first stationed at Wright Field together in 1939. He said, "I've finally got orders to go to the Naval War College." I said, "I've got news for you, Terry. You are going to come out and work for me on the West Coast." [Laughter] That's exactly what happened, so I did have authority to get people; Paul Blasingame [Col. Benjamin P.][78] was another example.

Marsh: May I comment here on management procedures? Before I do that, however, I also had an interesting observation from Wright Field. I stayed there until 1959, and I was in the Navaho program[79] until its demise. I would only observe that it's a good thing it was killed because all of our LOX [liquid

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[76] The Industrial College of the Armed Forces is located at Ft. McNair, Washington, D.C.

[77] In 1952 Colonel Terhune (1916–) went to Kirtland AFB, New Mexico, to work with the Special Weapons Center which was responsible for all atomic and nuclear weapons for the Air Force. He was one of a handful of officers assigned to the Western Development Division under General Schriever. Terhune was Deputy and Vice Commanding Officer of that program from June 1954 to May 1959.

[78] Colonel Blasingame (1919–) served in the Air Force from 1941–1959. Having earned a doctorate in aeronautical engineering from MIT in 1950, Colonel Blasingame headed the Air Force Academy's astronautics department from 1958 to 1959.

[79] The Navaho missile (SM–64) was designed to carry a heavy nuclear warhead, with a range of 5,500 miles and a speed of Mach 2.7. The missile, featuring a nonemanating pure inertial guidance system, was cancelled in July 1957.

oxygen] was going to WDD [Western Development Division]. [Laughter] They were taking over Rocketdyne rapidly and taking over Autonetics, so we would have died a natural death if we had not been killed because of the priorities, and that's as it should have been.

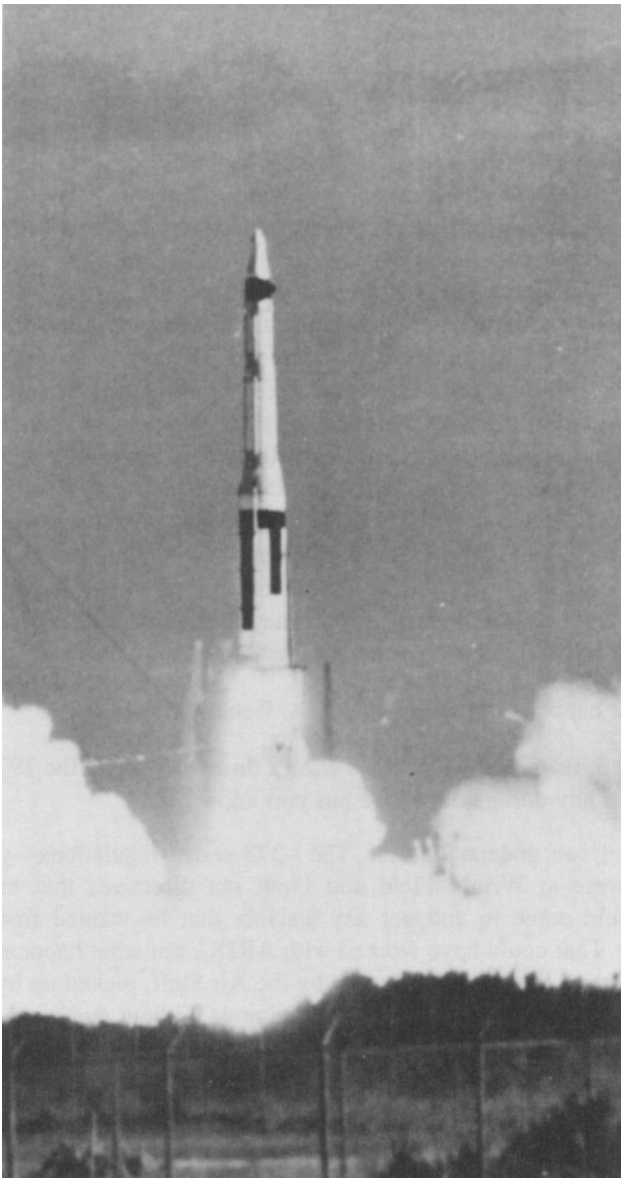
But as to management procedures, there is a very interesting historical paradox here. The BMD [Ballistic Missile Division] developed just as we've said; it made leaps and bounds advances in management techniques of weapon system acquisition. However, after the fact, people attempted to document all of that, to put it down into procedural volumes, and that grew into a thing called the –375 series of manuals. Then the Systems Command Headquarters, of course, had to institutionalize that. So they expanded upon it and staffed it *ad nauseam*, and expanded it in great detail. Then the Air Staff picked up on it and further institutionalized and expanded it in a series of Air Force –375 regulations. Then the Department of Defense thought it was so good they further embellished it and institutionalized it into a whole series of DOD directives regarding how one might manage a program.

The first thing you know, it just collapsed of its own weight. In other words, people tried to grasp the good essentials of how programs ought to be managed, and they overkilled it! The bureaucracy overkilled it. In fact, it became then the very bane of the process and had to be killed because all the flexibility had been taken out. So much effort was out to capture the good techniques that had been developed that they then became regulatory and there was no flexibility for the program manager to adapt.

Kohn: This happened in the early 1960s, General Marsh?

Marsh: Well, really the –375 series wasn't thrown out until the 1970s. I didn't mean that in any derogatory sense but you know. . .

Schriever: I can understand that. The –375 series regulations—you remember—you were at Wright Field and I put out directives that any program director could come in and get any waivers that he wanted from the –375 regulations. That could have worked with ARDC, but what happened is just as you say. A good thing was picked up by the Air Staff, picked up by DOD, and the first thing you know they were managing us without our having any waivers. Unfortunately, I think the way people operate and the way systems operate, they institutionalize almost anything that comes along. I have felt that you are lucky if any real good management approach in the bureaucracy lasts for five years. You are exceptionally lucky if it lasts for seven then you ought to throw it all away and start all over again. I'm not saying that now; I said it a long time ago. Fortunately for the ICBM program, we had about seven years where we had the kind of authority, procedures, and policy that I mentioned in the evolution of the management for the ballistic missile. It lasted about seven years.



The first Minuteman I launch at Cape Kennedy on February 1, 1961.

The 1960s

Kohn: But wasn't it the early 1960s, during the tenure of Secretary of Defense Robert S. McNamara,[80] that DOD began purposefully to draw authority away from the services?

General Schriever, in one of your oral histories you talked about the McNamara people squeezing the advanced development phase; you then used the term ". . . and they laid a bunch of vulture eggs that have hatched later on," mentioning the C–5 and the F–111. It seemed you were talking about the development process, and you said you saw the change in the early 1960s: the transition from the approach developed in the ballistic missile system to that of the 1970s and 1980s. Do I have that correctly?

Schriever: Well, I would have to check back. Certainly, as everyone knows, I was in complete opposition to the way in which McNamara was attempting to manage R&D in systems acquisition, starting about 1962. The micromanagement started then and has continued to worsen. I haven't been on the firing line so I'm not familiar with the details. For example, this recent move (which concerns me very much) is breaking up of DDR&E [Defense Development Research and Engineering] in the Pentagon where now they have taken the communications guy and set him outside of the DDR&E office, and taken acquisition out and set up an inspector to run acquisition. I don't know what is going to happen out of all of that, but I think it is absolutely the wrong move.

Communications is really the lifeblood of weapon systems. Take ESD [Electronics Systems Division], which is an absolutely vital part of the total job that you have to do in developing the weapon systems and making them play together. Now you've got somebody else at OSD [Office of the Secretary of Defense] level with the C^3 [command, control, communications] job and DDR&E is sitting over there with what's left, and the acquisition is under the inspector who makes a name for himself by saying we ought not do business at all; we ought to blackball some guys who were running some major companies.

Getting: I'd like to add to what's been said around this table. A bureaucracy will always proliferate more rules and more regulations. If there are problems, they will hide behind enforcement of those regulations to show their zeal and that their heart is in the right place. Like today, with the so-called problems on

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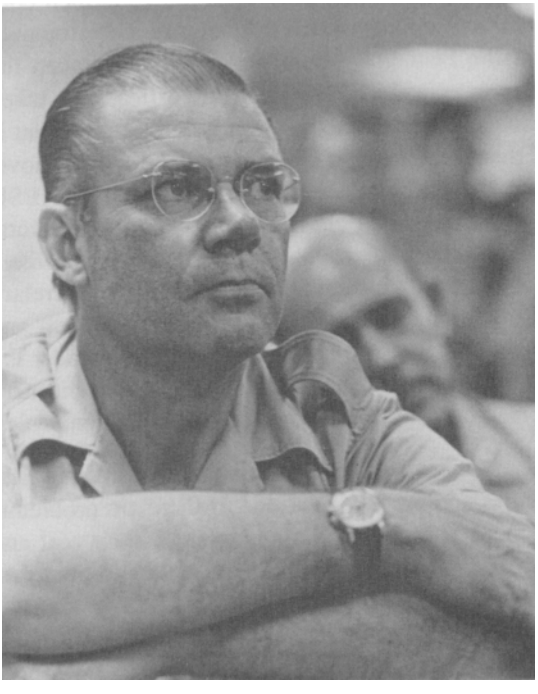
[80] McNamara (1916–) was secretary of Defense from January 1961 to February 1968.

spare parts and the costs of spare parts and other problems that have been unearthed, particularly in the Air Force contractors, there is such a plethora of that going down at the lowest level in organizations, with Air Force inspectors [digging] to find out whether the workmen know the regulations.

I think we could spend all our time in this kind of an effort and lose our productivity and certainly lose our creativity. I see nothing that has been getting any better. Bennie mentioned earlier that program managers now seem to be the staff people in Congress and that is largely true. There is very little initiative left to the Chief or to the Deputy Chiefs or to the Commander of AFSC. They have become in-basket, out-basket, going up the line, and coordinating everything to death to make sure that everything has been done according to the rules and regulations so they don't get fired. I think it's terrible!

Phillips: Getting back to the chronology of the evolution of organization and process. It was in 1961, at the time of the Air Force reorganization that established the Air Force Systems Command and the Air Force Logistics Command, I was in the Air Force Ballistic Missile Division and still responsible for the Minuteman program. The model of the commands was very much the model that had emerged from the experience in the ballistic missiles program and space program—an organization integrated with the engineering, the pro-



Secretary of Defense Robert S. McNamara

curement, all aspects of acquiring and getting a major system operational. On the acquisition side, the Systems Command side, the model was to integrate the engineering, procurement, and all aspects of acquiring and getting a major system to an operator. This became the model for the new commands. That was my observation, and that transition occurred, looking at it from a major program office level, without any change because we were already operating in that mode in the missile business.

Kohn: I wonder if the life cycle was the same in the airplane business?

Getting: I have had the opportunity for the last seven years to observe the current Air Force control and management of the development of large aircraft programs. I am very much impressed by the in-depth control and the systems approach that the current Wright Field is taking. The B–1 is an example. It is a far cry from the B–58 days.

Schriever: What you said about Systems Command is exactly right. When I took over ARDC, one of the first things that I was asked to do by James H. Douglas, Jr.,[81] the Secretary at the time, was to see if we couldn't straighten out the interface between AMC and ARDC.

You may remember the Anderson Committee[82] was set up—Sam Anderson [General Samuel E.][83] was commander of AMC at the time—and there is a rather full report on that, which you all have in your history. Anderson was a four-star general, all the other generals were three-star. We set up a working group of colonels that were picked from ARDC and from AMC. They were really the top colonels we had in the business. They had all had experience running programs and so forth. They were selected because of their competence. They were given the task and they came up with the recommendation of restructuring the two commands, which was exactly what finally ended up being the Systems Command and the Log [Logistics] Command.

Anderson was opposed to this and, finally, I was the only one who supported the colonels and submitted a minority report. We had an Air [Force]

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[81] Douglas (1899–1988) was Secretary of the Air Force from May 1957 until December 1959.

[82] The Anderson Committee was a weapon systems study group initiated in May 1959. Among the participants were General Schriever, ARDC Commander, and Maj. Gen. Mark E. Bradley, Acting DCS/Materiel at Headquarters USAF. The three men advanced different proposals. Anderson wanted to recombine AMC and ARDC; Bradley proposed to extend the "dual responsibility" approach from ballistic missiles to aeronautical and electronic systems; and Schriever proposed creating separate commands—one to manage weapons acquisition, the other to provide for logistical support.

[83] General Anderson (1906–1982) was Commander of Air Materiel Command from March 1959 to July 1961.

Council meeting and the decision was made by General White [Thomas D.][84] that there would be some changes in the Weapon Systems Program Offices [WSPO]—this was about early 1960 when this report came in—and gave a little more strength to ARDC with respect to the management of the program offices, but it didn't change anything at all.

When the Kennedy Administration came in, Ros Gilpatric [Roswell L.],[85] who became Deputy Secretary of Defense, was thoroughly familiar with all the fuming, fighting, and fussing that had been going on between ARDC and AMC for years because he was on my Board of Visitors. He had been Assistant Secretary in the Air Force, also Under Secretary in the Air Force. Ros called General White in, or went down to see General White, and said, "Look, Tommy, if you can straighten out this mess between AMC and ARDC, we will assign the space mission to the Air Force." That's what triggered off creating AFSC and AFLC because I was called in by General White who said, "You've got the job to come in and submit a report to me." I got Otto Glasser [Col. Otto J.][86] to work with Pat Gentry [Col. Ralph P.][87] who was Secretary of the Air Staff. We brought some colonels in. They wrote up the report in about two weeks then it went over to the White House and was approved.

General White called an Air [Force] Council meeting and said, "This is the way it's going to be; no more staff work to be involved." Bang! We had done all the work in the Anderson Committee so that was the reason we were able to put it together, but that's how it actually happened. It's entirely true that the management model, at least from a philosophical standpoint, was what had sort of evolved out of the ballistic missile program.

Marsh: Just for the record, since I was at Wright Field in the latter part of this just before AFSC was formed, the WSPOs as they were called—Weapons System Program Offices—were teamed, from ARDC and AMC. Once the outfit was formed up to do the job, we worked pretty darned well together, and I don't think we noticed friction within the office. There was baton-passing. Initially, the ARDC guy was the head of the program office and then I believe it was a production decision that he was relieved and an AMC guy was appointed the director. I think that's the way it was. But actually it was a very good team working relationship, even though it was awkward as the devil.

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[84] General White (1901–1965) was the fourth Chief of Staff of the Air Force, serving from July 1957 to June 1961.

[85] Gilpatric (1906–) served as Deputy Secretary of Defense from January 1961 to January 1964.

[86] Colonel Glasser (1918–) was General Schriever's special assistant and headed ARDC's Special Projects Office.

[87] Colonel Gentry (1916–) was Secretary of the Air Staff from December 1962 until June 1963.

Roswell L. Gilpatric (right) sworn in as Under Secretary by Air Force Secretary Thomas K. Finletter on October 29, 1951.

Schriever: You can always work well together; people can work well together under any kind of an organizational arrangement. From an industry standpoint, though, industry never knew where to go. They could play both sides against the middle. They always gravitate to where the money is, and the money was on the procurement side, so it was crazy! Absolutely nuts! Now I'm afraid it's going to happen again if the trend in the Pentagon has anything to say about it.

Getting: Let me assure you—I was in industry while this was going on—there were abuses. There were times when AMC, under the guise of buying production, would do R&D.

Schriever: Part of this occurs naturally in any large organization and a bureaucracy. The OSD has built up tremendously since its original concept of a small organization under Forrestal [James V.][88] when the Department of Defense was first established. For every one [congressional] staff guy that I had to deal

[88] Forrestal (1892–1949) was the first Secretary of the Defense, serving from September 1947 to March 1949.

with, there must be fifteen or twenty now. As a result, I can only conclude that the only time we change things is when there is a crisis. Well, I hope we don't have to have a war in order to change things. There are other ways in which crises occur, and there well may be one that changes things. I'm afraid it isn't going to change until there is some kind of a crisis, and I can't predict what that might be.

Kohn: Could I ask you all, now moving into the 1960s and 1970s, to address the evolution of the process by which this encumbrance happened. We've mentioned the Department of Defense. Were other factors at work?

Schriever: Let me start out on that because I was there from 1960 to 1966. I think the Vietnam War had an important part to play in this, too. The Vietnam War was highly political. The military really didn't run the war in terms of major decisions—certainly not policy or even major decisions with respect to employment of forces. I think the Systems Command, or the R&D aspect of the Air Force, did a good job in responding to the requirements of the Vietnam War. In other words, we had fast response, fast reaction times. We improved a lot of things, and I think the record will bear that out. What happened, though, is that the Vietnam War so overshadowed everything else that we were not allowing new systems to be developed. For example, Jerry Wiesner [Dr. Jerome B.],[89] the President's science advisor, said that we had "plateaued out" in the field of technology. You may remember that. We were on a plateau.

Getting: He wouldn't say something as stupid as that.

Schriever: He did say it. Jerry is a good friend of mine, but I had nothing but arguments with him. Over in DDR&E they strangled advanced development for fear that advanced development would lead to a new system and they wanted to nip it in the bud. Now that was never openly said, but that was in fact what was happening.

We were also in the process of accommodating the Soviet Union. We were talking about accommodation. Look at some of Johnny Foster's [Dr. John S., Jr.][90] speeches after I retired—he was still DDR&E, replacing Harold Brown[91] when Harold took over the Air Force. Foster began making speeches about the fact that we were not supporting technology and we were getting behind in the technology area. That period was the only period that I can remember where there were brakes put on technology. You can't stop technol-

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[89] Dr. Wiesner (1915–) was appointed by President Kennedy as Special Assistant for Science and Technology in January 1961 and served in this capacity for three years.

[90] Dr. Foster (1922–) served as Director of Defense Research and Engineering from October 1965 to June 1973.

[91] Brown (1927–) was Secretary of the Air Force from October 1965 to February 1969.

ogy. Technology is going to go on whether anybody wants to put brakes on it or not, and it did go.

I want to mention Project Forecast[92] in this regard. The report of Project Forecast was finished in 1963. The mechanism of Project Forecast was to get the people from the working commands, from our laboratories and so forth, within AFSC, get people from industry who were actually doers, get representatives from the operating commands. Now, Project Forecast did not get the blessing of McNamara in terms of some of the policy and some of the other recommendations made, but the guys who actually wrote the technical panel reports and those reports went back to their laboratories and did it anyway, you see! They believed it, so therefore they were the ones doing it. When people want to do something, they can get things done. So Project Forecast contributed a great deal in focusing technology that had big payoffs. I think you would agree with that.

Getting: Especially in the materiel end.

Schriever: Yes, right. But as a matter of policy from the OSD level, we were stifled, particularly in moving from exploratory development to advanced development. This is not only my opinion. However, I couldn't prove it because nobody ever said this overtly.

Getting: Let me mention another aspect of the Vietnam War. I happened to be on a WSEG [Weapon System Evaluation Group] Vietnam panel during the whole period so I was reasonably well acquainted with what was going on and sometimes critical of the Air Force. We have been talking about long, big projects, big developments, and all that. There was one example at Wright Field which stands out (and that was the gunship) of an in-house organization which, under very difficult conditions, responded to a wartime need for which there was no stated requirements. This was never approved, as far as I know, at the Air Staff level. They put together the gunship and sent it out there. It performed wonderfully well but, as soon as the war was over, it was dumped.

Kohn: The issue is the quick-reaction capability of the R&D community in the Air Force. I was wondering whether General Marsh, who was probably running the show, had any comments on that?

Schriever: Tom was out at Wright Field at the time, and you had the basket SPO, as a matter of fact.

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[92] This was a long-range study of the Air Force's scientific needs, begun in March 1963 and completed in February 1964. Projecting some fifteen years ahead, Project Forecast sought to improve the Air Force's posture "within the framework of U.S. policy and national security objectives." Maj. Gen. Charles H. Terhune, Commander of the Electronic Systems Division, headed the study effort.

General George S. Brown was Air Force Chief of Staff from 1973 to 1974 and Chairman of the Joint Chiefs of Staff from 1974 to 1978.

Marsh: I had the EW [electronic warfare], the recce [reconnaissance], and the gunships as well.

Getting: How come it was so successful, under conditions when the –375 regulations . . .

Marsh: We didn't abide by them, we did our own thing! A moment ago, General Schriever said, "A crisis causes you to throw the book out," I remembered LINEBACKER II,[93] when we ran out of chaff in Vietnam. Well, all of a sudden we generated a tremendous requirement for chaff because they put the F–4s[94] up ahead of the B–52s.[95] We were losing B–52s and the only thing we

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[93] In the final weeks of the war, President Nixon ordered a bombing campaign against North Vietnam. Nixon acted because North Vietnam had suspended, on December 13, 1972, diplomatic negotiations on a cease-fire agreement ending the fighting and returning U.S. prisoners of war. The bombing campaign, known as Operation LINEBACKER II, began on December 18 and lasted for 11 days. Air Force B–52s flew 729 sorties, and Navy and Air Force fighter-bombers flew approximately 1,000 sorties. A total of 20,370 tons of bombs were dropped on North Vietnam, damaging military and other government structures, electrical power networks, petroleum storage depots, railroad yards and tracks, and antiaircraft defenses. On December 29 the bombing stopped; North Vietnam agreed to resume negotiations. Three weeks later, on January 23, 1973, the final cease-fire agreement was signed by Dr. Henry Kissinger for the United States and Le Duc Tho for North Vietnam.

[94] The F–4 Phantom II is a twin-engine, all-weather, tactical fighter-bomber that can perform a variety of air roles—air superiority, interdiction, close-air support, strategic bombing, and reconnaissance. The F–4 can operate at speeds of more than 1,600 mph and can reach altitudes close to 60,000 feet.

[95] The B–52 Stratofortress is a long-range, heavy bomber capable of flying at subsonic speeds at altitudes up to 50,000 feet. It has been the primary manned strategic bomber for the United States for the last thirty years. The Stratofortress can carry nuclear or conventional ordnance and can perform a variety of missions, ranging from battlefield attack to sea control. The use of aerial refueling gives the B–52 a range that is limited only by the endurance of its crew.

could figure was to get tons of chaff over there quickly. We didn't have any! Didn't have any stored, so I called up all the chaff makers in the United States (I think it was Christmas Eve) and said, "Hey, we've got to have chaff; you guys produce it and we will figure out a way to pay you." You can't do that! You are obligating the government. However, General George S. Brown,[96] who was the commander [of AFSC] at the time, called next Monday morning and said, "Don't worry about it, Marsh; we will back you up." So I think you resort to all kinds of things in time of crisis and throw the book out. People don't get hung for throwing the book out when it's really required. That's exactly what gunships and everything else did, and a lot of electronic warfare efforts were done the same way.

Kohn: So you all would say, then, that the life cycle of R&D has lengthened in the last twenty years essentially because of micromanagement and bureaucratization?

Marsh: I was going to ask General Schriever along that line. The impact of the McNamara era, surely that was the beginning of micromanagement as we know it today, was it not?

Phillips: Let me start the comments in answering that and then it can be picked up from a different perspective. I mentioned earlier that we turned the first operational Minuteman missiles over to SAC in October of 1962. By then the Kennedy Administration, with Mr. McNamara as Secretary of Defense, had been in office about a year and a half. By that time, for reasons that were driven by things that were important to the top of the government and having to do with budgets, the Vietnam War and its needs, the Secretary of Defense was cancelling a lot of programs.

I recall that one of the programs cancelled was the mobile Minuteman, which was coming along very well in development. It was rail-mobile. As I think back on it, and have many times over the years, I think the Secretary was right in cancelling that program, but for the wrong reason. He announced that he cancelled it because it was in technical difficulty, which I know it was not. But as I think back over all the years since, we probably couldn't really have operated solid-rocket missiles with warheads on them on the nation's railroads, so the cancellation was announced for the wrong reasons.

It was in that same period that programs like the Skybolt,[97] which was an

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[96] General Brown (1918–1978) was AFSC Commander from September 1970 to July 1973.

[97] This was an air-to-surface missile under development by the U.S. Air Force for its B–52 fleet and the Royal Air Force's Vulcan bombers. A "stand-off" weapon that could be launched some 1,000 miles away from its target, the Skybolt was conceived in both nuclear and conventional configurations. Cancelled by the Kennedy administration, the Skybolt was succeeded in 1964 by the short-range attack missile.

(Left to right) General Schriever; Boeing's president, William A. Allen; and Maj. Gen. Osmond J. Ritland, Comander of the Ballistic Missile Division before a scale model of the mobile Minuteman ICBM.

air-launched ballistic missile being developed at Wright Field, and Dyna Soar[98] which was before its time (it was a small version of what the Shuttle is today) were all cancelled. It was also in that 1962 period that the Secretary of Defense announced that he would approve changes exceeding $10 million.

I remember that because as the Minuteman program director, and with my "change board," which was one of the innovations that we established as part of our process, we were making decisions daily, weekly, involving many tens of millions of dollars in committing changes in the system. That led me to observe that had the constraints, that were progressively beginning to be put on the management structures in the 1960s, existed in the late 1950s or early 1960s when we really developed that Minuteman missile and its system rapidly, we couldn't have done it. We could not have succeeded. I believed it then and I believe it now.

So for reasons that are always important at the top of the government, processes changed. As General Schriever said, the ballistic missile got started and had an opportunity to create a new structure, a management-decision-approval authority type of structure because it was a crisis. I still remember the campaign of 1959–60 that led to Kennedy's election in 1960. The "missile gap" was a big issue and it was a crisis. That was the crisis that then sustained the ability of the Air Force, in parallel with the Navy with its Polaris, to operate with highly delegated, decentralized authority and processes to be able to get a job done. In short, let people accomplish what they are able to do if they are not constrained.

Then, as you come into the 1960s, there were a different set of forces at the top that caused priorities at the top to change and programs to be cancelled and constraints to be imposed. I think those constraints had as their purpose to have control over where money went and what that money then produced. Those constraints, in turn, then stifle the organization and its true ability, when unconstrained, to be able to get a job done.

Schriever: You mentioned the Skybolt. The Skybolt had a rather poor test record. That was cancelled and technical reasons were given for it. Although the day after the announcement that it was cancelled, I authorized the firing of a Skybolt missile from Eglin [AFB, Florida] and it was 100 percent successful, which did not endear me very much to the Pentagon. They tried to prove it wasn't successful for about the next six months. They also cancelled the mobile, medium-range ballistic missile.

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[98] The Dyna Soar (X–20), named for dynamic soaring, was an aircraft designed to explore the possibility of developing manned, recoverable, orbital vehicles. The first air drops from a modified Boeing B–52C were planned for early 1965 and the first orbital launch for early 1966. However, due to the emphasis placed on ballistic missiles by the Air Force, funding was halted on the X–20 and none were actually built, only the full scale mock up.

Now those cancellations were not for technical reasons, but for policy reasons. The Pentagon administration did not want Europe to have a strategic nuclear capability. They didn't want the British to arm their Vulcan bombers with Skybolts, which had a 1,500-mile range and would have given the British strategic capability. They didn't want mobile, medium-range ballistic missiles running around Europe even though they were under our control, like the Thors were.

As part of the settlement of the Cuban Missile Crisis, we withdrew all of our Thors and Jupiters, even though communist missiles were already in Eastern European countries. They were all "soft," just like ours. As a matter of fact, our missiles were far superior to theirs from a technical standpoint. Those actions were taken for policy reasons and not for technical reasons. What I'm saying is: policy constraints had a lot to do with slowing down the technology during that period. Now had we gone ahead with those mobile, medium-range ballistic missiles, (what Khrushchev[99] pounded the table for in the U.N. in 1960) we never would have had the big crisis in the late 1970s about putting mobile Pershings over there [in Europe]. Nobody admits they were wrong policy-wise then, far from it. But they were.

Getting: You are talking now about grand policy, international policy. Is not the Air Force also constrained many times by local politics, like that having to do with base closings or closing down an airplane plant somewhere?

Schriever: Sure, Ivan, but that really doesn't slow down the technology. It's the big policy decisions that slow down technology. As commander, I used to laugh when all this stuff would come up, for instance, "They are going to close Rome [Air Development Center]." Well, Rome is still there. It won't be until "Rome burns" that they close it! [Laughter]

[99] Nikita Khrushchev (1894–1971) came to power following the death of Stalin in 1953. A dominating, often crude figure, he attended a session of the United Nations General Assembly in New York and when a speaker made some anti-Soviet remarks, the Soviet leader shouted back obscenities, pounded his fists, and removed his shoe, banging it repeatedly on the desk.

The 1970s and 1980s

Kohn: General Phillips, you and General Marsh had to help manage this system as it became encumbered in the 1970s and 1980s. We've tried different methods of RD&A: "fixed price," "cost plus multiplier," "fly before buy," "prototyping," "total package procurement." What were your difficulties?

Phillips: I think an organization, first of all, accommodates to the environment. It was necessary for the [Air Force] Systems Command to accommodate to the requirements of the U.S. Government for how things were going to be done. First of all, you do have to structure it in a way that it can operate effectively within that set of rules, laws, requirements, and pressures. One of the end results of all that is a very, very long time to travel from the initiation of a major weapon system to having it finished, and in the hands of an operational command.

Two programs that I paid a lot of attention to when I commanded [Air Force] Systems Command in the middle 1970s were the F–15[100] and the B–1.[101] The F–15 program, the management of which was centered at Wright Field, at the Aeronautical Systems Division of Systems Command, was a tremendous step forward in fighter airplane technology. It had been set up by my predecessors with some special management procedures. Ben Bellis [Maj. Gen. Benjamin N.],[102] who was the program director, was essentially given direct access to the commander of the Systems Command, and in turn, even to the

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[100] The F–15 Eagle first flew in July 1972, and is an all-weather, extremely maneuverable, fighter aircraft designed to gain and maintain air superiority in aerial combat. Its weapons and flight control systems are designed so one man can safely and effectively perform air-to-air combat. Six of the eight world time-to-height records set in 1975 by the F–15A, Project Streak Eagle, remain unbeaten. These include a climb to 65,616 feet in two minutes, 2.94 seconds.

[101] The B–1B, first delivered in June 1985, is a multi-role, long-range bomber, able to fly intercontinental missions without refueling and penetrate present and predicted sophisticated enemy defenses. The B–1B currently holds thirty-six world records for speed, payload, and distance. The B–1B is a strategic penetrator that can perform as a cruise missile carrier or as a conventional weapons carrier for theater operations. Significant advantages of the B–1B over the B–52, the current mainstay of the strategic fleet, include: lower radar cross-section to make detection more difficult, ability to fly lower and faster while carrying a large payload, and advanced electronic countermeasures to enhance survivability.

[102] General Bellis (1924–) directed development of the F–15 from July 1969 to March 1974.

The McDonnell Douglas F–15 Eagle at its rollout on June 24, 1972

Chief of Staff. That was a special process[103] that was entirely within the allowable system. The F–15 succeeded admirably and was a very, very successful program, so that's one of the kinds of things that we did within our own structure, setting up a special process where that was important.

The B–1, had a whole different set of pressures on it, in the period when I was commander of the [Air Force] Systems Command and General George Brown was Air Force Chief of Staff for a brief period before he moved over to be Chairman [of the Joint Chiefs of Staff]. One of the things George Brown and I did was to call a meeting of all the active four-star generals of the Air Force to spend the hours necessary to debate the question of whether or not the Air Force really was going to commit itself to acquiring the B–1. That was the first step: get the Air Force really committed and that happened. As a result of that, General Brown as Chief of Staff appointed a deputy, Jim Allen [Lt. Gen. James R.],[104] as a special project officer. Allen reported directly to the Air Force Chief of Staff on B–1 matters. For a number of other reasons I caused some changes in the direction of the program office and actually moved Ab Martin [Maj. Gen. Abner B.],[105] who was the Minuteman program director, from California to Wright Field to take charge of the B–1.

There were things we could do within the constraining process. But among the things that had to be done was a careful and thorough job of planning, a structure of competent engineering and technical attention, and a rigorous approach to managing the whole process. Only then could we accomplish what the upper levels planned and committed the organization to. It's partly in that

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[103] The "Blue Line" system was a direct reporting channel from the Systems Programs Office to the commander of AFSC, to the Chief of Staff, and to the Secretary of the Air Force.

[104] General Allen (1925–) served as special assistant from January to August 1974.

[105] General Martin (1927–) was appointed B–1 System Program Director in January 1974. He served in that capacity until September 1977.

The first three Rockwell B–1A bombers parked at Edwards AFB, California, in June 1976.

latter area that I think the bureaucracy tends to progressively centralize. When the lower levels which are responsible don't perform to their commitments, you find you will always get more help through the upper levels than you want. I guess I've pitched all that in a fairly positive vein, which is, I think, the correct way to look at it.

All of this occurs on top of a large structure of normal programs that are going forward. They are subject to the normal procedures, which involve any plan for a project, program, or major new thing being developed at a low level in a division, then rising up through the division, the command, the Air Force Board Structure, the Air [Force] Council, and on into Congress. It is a tedious and lengthy process that consumes a lot of time. I think, therefore, that the process adds considerably to the cost of getting things accomplished because it takes so long and so many people have to devote so much time to it, including contractors, when they get into the process.

Marsh: I agree 100 percent with what General Phillips has said. You will be a loser if your goal is to come in and to reform all of this bureaucracy. You'll never get anything done. Your challenge is to adapt to the bureaucracy and manage within it as efficiently as you possibly can. You will frustrate yourself and the whole organization if you decide you are going to overhaul the bureaucracy, because you can't.

There are some interesting anomalies, however, within what we've discussed. If the NSC [National Security Council] and certain key people in OSD want [a] program, like the cruise missile program to go, then all the procedures get thrown out the window. You can almost pursue them at a reckless pace. On the cruise missile program we, the Air Force, had to run to clean up behind the cruise missile development in an effort to make sure that it was fielded properly. So, if at the top of the bureaucracy they decided that something must be done fast and done well, it can be done.

The resurrected B–1 program, the B–1B, I would judge has proceeded remarkably well. Its pace has not been inhibited by the bureaucracy, once it was resurrected, because the President endorsed it, OSD endorsed it, and the Air Force has done a good job. Things can still be accomplished. There are some lessons there, one of which is that you must have a consensus throughout the bureaucracy. Congress almost stopped the B–1 but didn't. If you can have that consensus, the system will still produce results.

Getting: Let me add a little bit to the B–1 with respect to the SAB. The B–1, as you know, was cancelled by President Carter after he listened to options that were presented by Harold Brown, who was then Secretary of Defense. It lay in hiatus. The Deputy Chief of Staff, Research, Development and Acquisition,[106] at that time asked the SAB to study what he "invented": a new name, the LRCA [long-range combat aircraft]. He was on very tough political ground because the B–1 had been cancelled, and it is very hard to resurrect a program that has been cancelled. He asked me to head it and the SAB to undertake an intensive study on what should be not only the technical solutions to the Air Force's long-range combat aircraft, but also what should be its missions. That was a rather unique challenge because the Air Force quite properly generally keeps its concepts of warfare and its missions to itself. The uniformed military are the professional experts, and they hardly ever turn to amateurs for that kind of advice.

But as a result of this request, there was a study set up, the LRCA Study, which was unique in a number of features. One was that it integrated all the Air Force laboratory people: Wright Field and their advanced planning; the aircraft design people and their engine people; every major contractor—Lockheed, Boeing, Northrop, Convair; all aircraft engine companies, including General Electric and Pratt and Whitney; all the major air-to-air missile people including Raytheon and Hughes; even university people—practically everybody you would know in this group. It was a very large group, about 100 people.

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[106] Lt. Gen. Kelly H. Burke (1929–) filled the position from November 1972 until July 1982.

We got a ruling from the General Counsel of the Air Force, that since we were so broadly represented, there was no conflict of interest. That was important because we had become very sensitive to conflict of interest, and if anybody knows anything about a subject, you can't put them on a committee or a study any more. This was just the opposite. We went to the far extreme and we got it in writing that there were no conflicts of interest. We had a direct line to the computers at Wright Field. They kept doing analyses—Willie Hawkins from Boeing and God-knows-who-else, practically everybody there—and we produced a report in six weeks.

We had problems with SAC, too, because SAC was playing politics. They wanted the FB–111A stretched because they thought they could get away with that. I say that purposely and I mean it. SAC didn't want the B–1 because they thought it would never sell politically. The results were reported out and incidentally, we had practically every strategic thinker from the Air Force, retired and on board, to help us in the study analyses. We invented the term "imprecisely located target." Why would you ever want to send an airplane with a man in it? If you knew the coordinates, you might as well do it with a ballistic missile because it is cheaper and better. There had to be a strategic role for the long-range strategic combat aircraft and that was where the imprecisely located target concept came in. Of course, there were tactical missions involved in the conventional war, and what Bennie knew from back in 1950 was that if you want to deliver a bomb somewhere in the world, the cheapest way to do it is with an airplane, not with a ship.

The result of that study was that the B–1 received revived respectability, because everybody had input. It was a consensus (you were saying you have got to get a consensus). This consensus was built up through that report and it wasn't long after it was approved and the B–1B contains all the changes that were in that report. So I just want to point out that the SAB continues to be useful as a sort of a forum where you can pull together these *ad hoc* studies to meet special situations. Another one was the big bird that followed a few weeks later.

Phillips: You mentioned a number of techniques that are current, and have been required for some years, like the type of contract, C-spec[107] and so on. I guess I see all those as having an important place in the evolution of the processes. I think there has been a need, and there continues to be a need, for trying to find and develop the best ways in which the government can contract with industry. The problems that develop, however, are significant in terms of

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[107] A C-spec is a military standard specification practice. DOD provides for various levels of performance a contractor must meet—from an "A" level, or broadest requirement, to the "C" level (or C-spec), the most demanding requirement. The point made here is that the particular service should be allowed to specify details, not DOD.

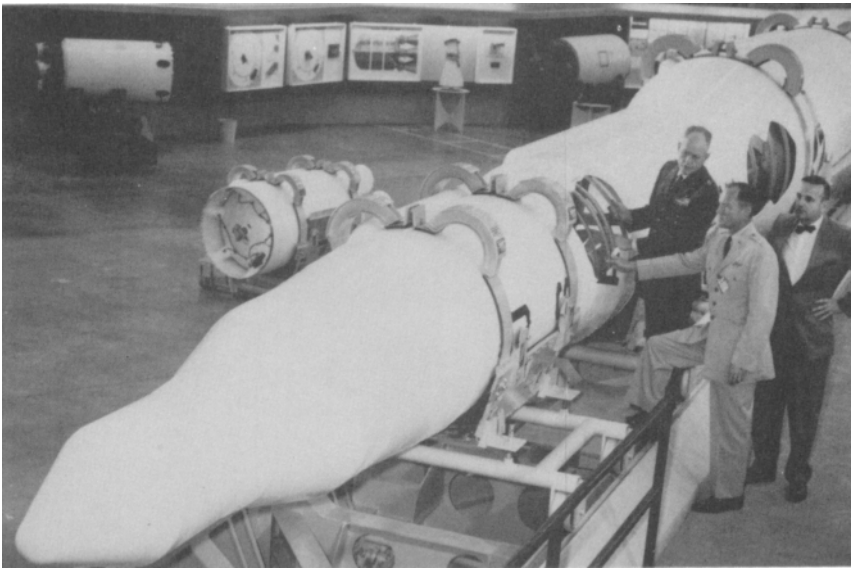
the amount of paper that becomes involved and the amount of time that becomes involved in going through the current methods of contracting. Another concern is the cost that the government has to pay, whether it's for their own people or for people in industry, to implement the tedious processes that are required. For example, C-spec is a dramatic example of a very costly process, the need for which emerged as part of a mechanism to produce results according to what had been planned and committed when budgets and program plans were approved either in the Air Force, Department of Defense, or Congress. It's all part of a process to try to improve. The dichotomy is that oftentimes the improvement impedes. It adds costs and doesn't produce the good results that it is intended to produce.

I personally prefer another approach: set up a reasonable set of rules of the game and then delegate and decentralize to permit good people, with the competence to plan and execute jobs, to get it done. Don't impose on them all the bureaucratic processes that are supposed to make a system work, no matter who is in it. I think that's the period we are in now. I feel that in the middle 1950s the crisis that caused the need for ballistic missiles (which permitted a revolution of the procedures to occur) is badly needed again. I think we have now become so bureaucratized, for reasons that have valid origins, that we are again in a situation where it takes two or three times as long as it necessarily should—and probably costs two or three times as much—to accomplish something important. I think we are at a point where there is a need for another revolution of the process. I don't know what the crisis is going to be that will cause that to happen, but it probably will require a crisis.

Marsh: Incidentally, I think we haven't touched something I think is of historical importance: Air Force support for the basic research and technology base that it will need in the future. I've seen a trend over the last twenty years or so of decreasing support to our technology base programs in the Air Force. I believe that is of critical importance. I've seen the trend; the trend exists of decreasing support to the technology base. Now it turns out that SDI [Strategic Defense Initiative] may tend to offset this problem that was, in my judgment, getting to be an acute problem. SDI technology, just by the nature of technology, will benefit much beyond its narrow purpose.

It is an important aspect of our history that the Air Force, early on, was very heavily technology oriented. History will show that the service allocated something like 2 percent of its annual total obligation authority to technology base programs. In the 1970s, under the severe budget crunch that we had (having to divert earlier to Vietnam and then subsequently to cuts during the Carter years) we drew down to about 1.3 percent, and we haven't restored it. We have not built back up beyond that number today. Maybe the SDI program will offset that.

Phillips: I would like to comment about space, since all of us around this table had some involvement in those programs. We haven't really talked much



Col. Samuel Phillips (center), Minuteman Program Director at the Air Force Ballistic Missile Division; Maj. Gen. Osmond J. Ritland (left), Commander of the Air Force Ballistic Missile Division; and Mr. T. A. Wilsom (right) of Boeing inspect a full-scale mock-up of a Minuteman.

about it. I joined the Ballistic Missile Division in 1959. Just before I got there, General Schriever had moved to be commander of ARDC. The Ballistic Missile Division was organized in two major parts. One was ballistic missiles; that's the part I was in, with the Minuteman, Atlas, Titan, and others. The other part, however that we haven't talked about, was space. There was a deputy commander for the space portion, as I recall, it was Dick Curtin [Col. Richard D.].[108] Harry Evans [Col. Harry L.][109] was involved in that period also.

There were some very significant programs in that space portion. The program that was then called Midas was really what later became, in a somewhat different incarnation, the Defense Support Program (DSP). It had its beginnings, in the middle or late 1950s, as Midas. There were other programs that were going by special names that were later converted to be what today are mainstays of the defense structure. That is point one.

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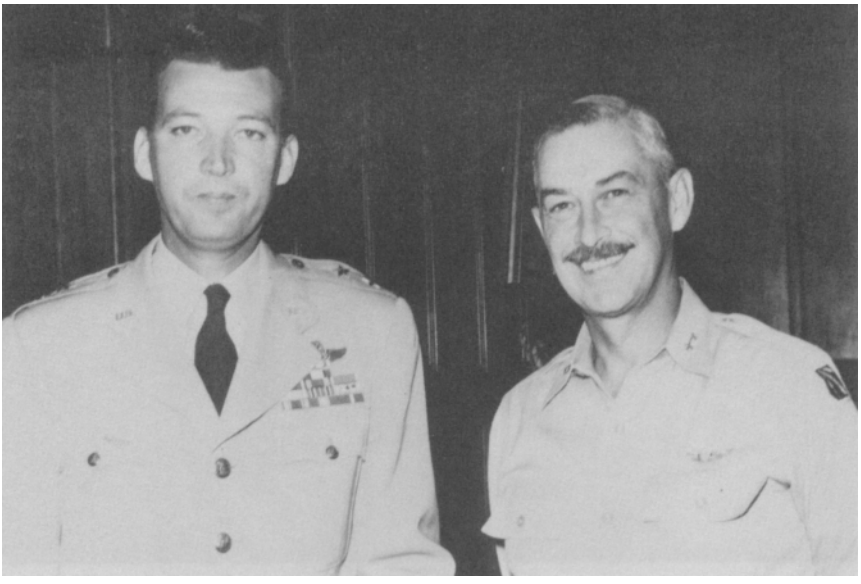
[108] In February 1958, Colonel Curtin (1915–) became Deputy Commander for Space Programs at the Air Force Ballistic Missile Division and remained in that capacity until June 1960.

[109] Between October 1958 and March 1960, Colonel Evans (1919–) served as Assistant Deputy Commander for Space Programs at the Air Force Ballistic Missile Division.



Rival commanders of missile development programs meet. (Left) USAF's Maj. Gen. Schriever and the Army's Maj. Gen. John B. Medaris.

Another large area of activity going on in that same period (I was observing it more or less as an outsider, while General Schriever could give you hours of lecture on this) was the contest between the Air Force and the Army over roles and missions for ballistic missiles. Bruce Medaris [Maj. Gen. John B.][110] was an Army general very much involved in that period. This was occurring in the late 1950s, sparked by Russia putting up the first Earth satellite, *Sputnik*, in the fall of 1957. A crisis was created, a crisis of confidence in the country. People said, "Hey, all of a sudden we've lost our ability to do things." That in turn caused the administration to create NASA [National Aeronautics and Space Administration], the Space Act in 1958, and to assign to NASA the civil mission to develop the ability to operate in space for the benefit of all mankind. The secondary mission in that law was to support other national needs for space developments, in particular in the Department of Defense, with technology and so on.

As those crises mounted, President Kennedy decided to establish the *Apollo* Program with its goal of landing men on the Moon and returning them by the end of the decade, which we later defined as by the end of 1969. Those events and the crises that were occurring (some of them coincide with other crises,

[110] General Medaris (1902–1990) was Commanding General of the Army's Ballistic Missiles Agency from 1955 to 1958 and headed the Ordnance Missile Command at Redstone Arsenal, Alabama, from 1958 to 1960.

like Vietnam), I believe profoundly influenced the organization, process, and procedures for research and development.

As you know I was assigned—General Schriever played a part in this—on detached service in late 1963 to NASA to become the *Apollo* program director. I stayed in that position until the latter part of 1969 after *Apollo 11* had landed and accomplished that mission. By late 1963 my observation was that NASA had developed to be a very, very professional technical organization, but they had almost no management capability nor experience in planning and managing large programs. They had tremendous technical competence and depth, but very little experience and people with experience in management. That's why Jim Webb [James E.][111] came to the Secretary of Defense, and, in turn, that led to my assignment because of my experience in the Minuteman program in particular.

One of the first things I did after learning some of what was going on in NASA and the *Apollo* Program (which was still in its formative stage), was to go back to Curt LeMay as Air Force Chief of Staff and General Schriever, then Systems Command commander, and in turn to Secretary Zuckert [Eugene M.],[112] to ask for some help. We wound up in a matter of days with fifty Air Force officers assigned in key places in the NASA centers and elsewhere in the agency.

Schriever: Sam got even with me. I made him available to NASA, then he robbed me!

Phillips: That's what we had to have, though: people with experience to manage the programs.

Getting: By the same token, for a year in 1950 I was Bennie's boss in the Air Staff. Then in 1960 he got me stuck running Aerospace Corporation so he could boss me for the next eight or nine years.

Schriever: I got even!

Getting: When I reflect on it in another way, Bennie has been a great supporter. If it hadn't been for Bennie Schriever, I don't think the Air Force would have been as dominant a player as it has in the military space programs.

Schriever: Dick [Dr. Kohn], you heard me talk about space the other day when we had an Air Force Historical Foundation meeting. Of course, I'm getting more and more annoyed over the fact that there really is not a good

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[111] Webb (1906–) was NASA Administrator from February 1961 to October 1968.

[112] Zuckert (1911–) was Secretary of the Air Force from January 1961 until September 1965.

history of the Air Force space program. All you read about is the NASA space program. I think we need to do something about it. The Air Force got into space when General Arnold created the Rand Corporation. The first mission he gave Rand was to determine the feasibility of a reconnaissance satellite. Shortly after we started the ballistic missile program, Rand came up and said a reconnaissance satellite was feasible. Now I won't go into that any further. But we were interested in space way before *Sputnik.*

Marsh: I was the program officer at Wright Field before *Sputnik.*

Schriever: I'm just going to recite a few little things. These are not intended to be complaints or intended to be critical of anyone, but to recount what actually happened.

In February of 1957 I made a speech in San Diego [California] which had been prepared by Si Ramo and myself. We had decided that it was time to talk about space. There was a symposium down in San Diego, and I made the speech. In it I said that we were ready to move forward into space, that the ICBM provided all the resources and know-how within the government, and in industry, and that we should move forward rapidly into space. Well, I received instructions the next day from the Pentagon that I shouldn't use the word "space" in any of my future speeches. Now that was in February of 1957! They had the IGY [International Geophysical Year][113] going you know, which was kind of a scientific boondoggle. Yet, we couldn't get anything going for space.

I recall I went to the Pentagon building during that year and finally I got $10 million. By that time the 117L program had been moved to the West Coast and was under my command, but I guess we called it BMD [Ballistic Missile Division] at that time (we changed names so frequently). I finally got $10 million from Don Quarles, who was Secretary of the Air Force, with the instructions that we could not use that money in any other way except for component development. No systems work whatsoever. Ten million dollars!

Now mind you that was in the middle of 1957. As Sam pointed out, *Sputnik* came along in October of 1957 and all hell broke loose. I was going back and forth to Washington sometimes twice a week, mostly on the "Red Eye"[114] one way or the other, making presentations to the Pentagon or the Congress. "Why can't we go faster? Why can't we do this? Why can't we do that?" There is a crisis for you, you see! All of a sudden things changed overnight. Overnight!

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[113] In October 1954 a committee of the International Council of Scientific Unions proposed the launching of small scientific satellites between July 1, 1958, and December 31, 1958, the so-called Geophysical Year. General Schriever's pique here aims at the fact that only the military in the U.S. possessed any significant space expertise.

[114] The "Red Eye" was the nickname for an overnight flight from Los Angeles to Washington, D.C.

Visitors to Moscow's Academy of Sciences Pavilion view a display of *Sputnik*, which became the world's first artificial satellite on October 4, 1957.

Out of all this came the creation of NASA [and] DARPA [Defense Research Projects Agency], called ARPA [Advanced Research Projects Agency] at that time. I testified on the creation of those organizations, and I had some reservations about both, which proved to be correct. And we got into the space for peaceful purposes. That sort of masked the need for space assets for national security, although the NASA Act made it very clear that national security had an important role. But we had to fight every inch of the way.

Now some other things happened that I won't go into which also inhibited the military from moving forward, except in the one major area of strategic intelligence. That area was covered, but insofar as developing assets for the military operational commands, the structure was not created to do that very easily. We were inhibited and went much slower than we could have gone had we not had some of these inhibitions. These were not inhibitions from the standpoint of capability, being able to manage, or knowing what was needed (in particular the C^3). It was the support area, the C^3I area. I think we finally overcame that.

The President issued three policy statements. The two most important were the space policy document in 1982 and the last one was just in the fall of last year on space strategy. Those are highly classified documents, but they clearly state what we should be doing in terms of using space to the optimum

for national security purposes. It is up to the Air Force to get on the ball and do something.

Now they did create the [Air Force] Space Command. The Space Command is developing requirements; they are working with the [Air Force] Systems Command. I think the old bugaboo about making a service out of the Space Command is gone. I talked to General Herres [Robert T.][115] the other day, and he is 100 percent for it. He knows what an operational command is supposed to do and what the Systems Command is supposed to do. I think the space thing should be given a completely separate day in court because there are many, many things that have not been really aired in terms of what has been done because of the high security associated with some aspects of the program. But the time is right to come out and tell the story with respect to what the Air Force, particularly the Air Force, has done in connection with space. I am glad it has been brought up. To me it is the most important challenge that the military has and the Air Force, again, should be taking the lead in optimizing space assets for national security purposes.

Kohn: We have time to go around the table and make some final comments. We have talked a lot about lessons, weaving them into the discussion from the very beginning. If you want to sum up, or make a final point about lessons learned from your research and development experiences, please do.

Schriever: If you want me to start, I will just say: If I had to do it all over again, I would do the same things. It has been the most fantastic century in the history of mankind. We dwell on some of the problems, but we also should look at some of the successes.

Kohn: We have been successful in research and development in this country.

Schriever: Damn successful. I was just looking last night when we landed at those airplanes parked in the general aviation area all the jets and so forth. I was thinking back to when I started to fly, only twenty-nine years after the first flight at Kitty Hawk [North Carolina]. Think about what has happened since then. We circled the globe; we fly at many times the speed of sound. There is no question in my mind that the Wright Brothers had absolutely no concept of such advances in such a short period of time. I have always said that we tend to overestimate in the short run, and underestimate in the long run. I think that has certainly been true in what we have done in aviation and what we have done in space. If we could eliminate all the bureaucrats, we could do it faster, that's all!

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[115] General Herres (1932–) was Commander, United States Air Force Space Command, Peterson AFB, Colorado, from 1985 to 1987.

Phillips: I think the most significant lesson is the importance of good people, and developing those good people through education and various programs that give them incentives and motivation. In that connection, then, I think the importance of not overconstraining, establishing the organizational structure, and the hierarchy of decisions and authorities in a way that provides a large delegation for initiative at the lower level is essential. Those are the kinds of lessons I think are important.

Marsh: My point is that I am deeply disturbed by this trend that we have discussed here, this trend toward centralization and elevation of authority (not of responsibility, but authority). I guess I have to say I am praying for a crisis but I do not mean one that threatens our very existence. But I want to see this constipation relieved. It is worse than it has ever been in our history. I worry about the trend and where it will take us? Will it take us to the point where we just can't get anything done? That's the historical perspective I have: that we used to be able to get things done fairly fast and they were giant strides. I hope we are not getting into where we can make incremental strides at very, very great pain and labor.

Getting: I endorse every summary that's been made so far. I think we went through the wringer at different times and different ways, some backwards and some forwards, but it is the same world that we are describing. I think this need for history of Air Force activities in space is very, very necessary and I hope your organization can find some way to do it.

Another point I would like to make is that the Air Force is viewed in the eyes of many people in a negative way. People don't want to work for the Air Force, its research, or in DOD, because they think of it as a bad thing. The Vietnam War was blamed on the military when it was really civilian-run. It was set up by civilian policy. So I think it is important to stress some of the achievements that the Air Force has made and the contributions it has made to the public in addition to defense. You look at the world today and everybody flies by airplane whether they go from here to LA [Los Angeles, California] or from here to India. They don't go by train; they don't go by boat; they go by air. They communicate, navigate, and practically everything that brings about this advance has come out of Air Force research and development.

Many years ago when I was trying to sell the NAVSAT [Navigational Satellite], I went to Lee DuBridge,[116] the President's Science Adviser at that time. I suggested that a Presidential commission be set up to review how satellite navigation should really go forward because there were so many users: the Coast Guard, foreign countries, Air/Sea Rescue, the Air Force, Navy,

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[116] Dr. DuBridge (1901–) was science adviser from January 1969 to August 1970.

and Army. He said, "Well, let me think about it." So about a month later I came back and I said, "What's the result of all your wisdom? By now this country should proceed in developing the navigation satellite." He said, "Well, I thought about it and decided it was too hard to get from here to there. There are too many people, too many bureaucracies, too much politics, and too many agencies involved. Why don't you just have the Air Force develop it the way we always did?"

Phillips: Ivan used to tell me that he wouldn't retire from Aerospace [Corporation] until we had an active NAVSAT program. I think he stuck with that.

Kohn: Let me thank all of you once again for taking the time and trouble to come here and to share your experiences with us frankly, candidly, and with humor and wisdom. It has been a valuable experience for those of us in the room and I think it will provide an enlightening story for the United States Air Force, for the Department of Defense and for the country. Thank you very much.

Glossary

ADSEC — Air Defense System Engineering Committee
AEC — Atomic Energy Commission
AFSC — Air Force Systems Command
AGL — airborne gun laying
AI — airborne intercept
AMC — Air Materiel Command
ARDC — Air Research and Development Command
ARPA — Advanced Research Projects Agency

BMD — Ballistic Missile Division

Convair — Consolidated Vultee Aircraft

DARPA — Defense Advanced Research Projects Agency
DCS/M — Deputy Chief of Staff/Materiel
DDR&E — Defense Development Research and Engineering
DOD — Department of Defense
DSP — Defense Support Program

ESD — Electronics Systems Division
EW — Electronic Warfare

ICBM — intercontinental ballistic missile
IGY — international geophysical year
IRBM — intermediate range ballistic missile

LOX — liquid oxygen
LRCA — long-range combat aircraft

MEW — mobile/microwave early warning
MIT — Massachusetts Institute of Technology
MTI — moving target indicator

NACA — National Advisory Committee for Aeronautics
NASA — National Aeronautics and Space Administration
NDRC — National Defense Research Committee

OSD — Office of the Secretary of Defense
OSRD — Office of Scientific Research and Development

R&D — research and development
RD&A — research, development, and acquisition

SAB — Scientific Advisory Board
SAC — Strategic Air Command
SDI — Strategic Defense Initiative
SE/TD — Systems Engineering and Technical Development
specs — specifications

WDD — Western Development Division
WSEG — Weapon System Evaluation Group
WSPO — Weapon Systems Project Office Index

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